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Engineering News

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Advertising Index, Last Page

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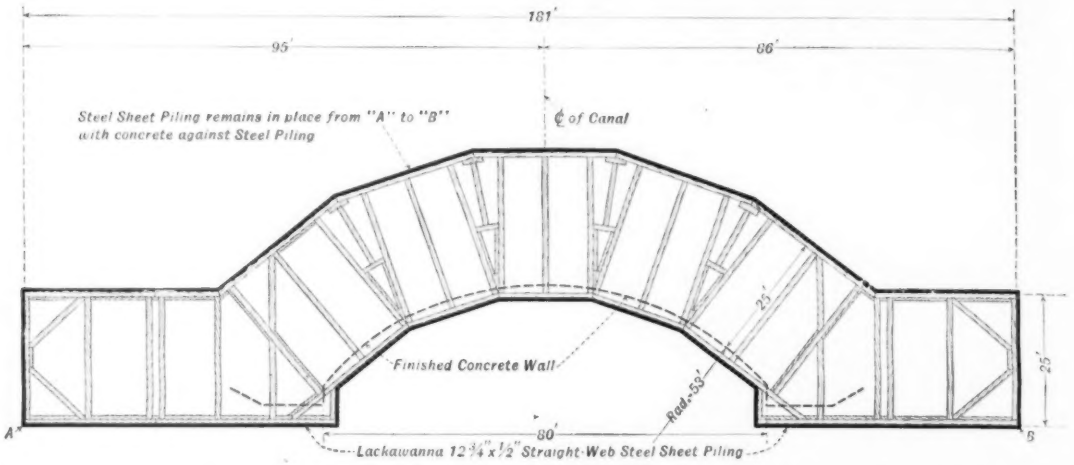


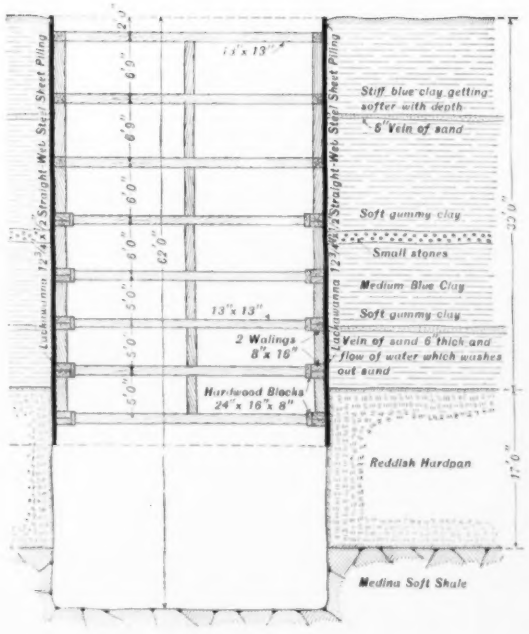
Lackawanna Steel Sheet Piling Cofferdams For Breast Walls of Locks Nos. 2 and 3 of the New Welland Ship Canal

The two locks on the Welland Ship Canal, now being built by Baldry, Yerbaugh & Hutchinson, Ltd. of St. Catherines, Ont. on a $5,500,000 contract are each substantially 80 feet between walls, 800 feet long and 30 feet over the miter sills. The breast walls for each of these locks had to be built within steel sheet piling cofferdams in order that there should be no disturbance of the material on upstream side which has to carry the forebay walls and floor.

The most efficient and economical material for these cofferdams appeared to be Lackawanna 12¾ by ½-in. Straight-Web Steel Sheet Piling driven in 45-foot lengths down to hardpan, and shorter steel sheeting, if found necessary for the remaining 15 feet down to bed rock. The design and general plan of bracing adopted are indicated in the accompanying plan and elevation. The steel sheeting on the front side from A to B (plan) was to be removed and the finished concrete wall exposed, while the steel sheeting on the back and sides was to be left in position permanently.

Both of these cofferdams have now very successfully served their purpose, the excavations being completed and the concrete walls being finished to ground level.

Further details as to the driving and performance of the steel sheet piling will appear in our next week's advertisement, and other large cofferdam work is described and illustrated in our book—"Lackawanna Steel Sheet Piling" which will be sent to any managing engineer on request.



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Engineering News

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Building Power House and Dam on Sand Foundation

SYNOPSIS—Power house and 1,000-ft. concrete dam built upon the deep sand bed of the Wisconsin River. Sand confined between lines of steel sheeting and covered with loose rock. Wood piles driven within the inclosure. Special protection against wash at downstream side of dam. Electric industrial railway, with remote control of movements of the cars used for handling material. Construction plant and methods are described.

The hydro-electric plant of the Wisconsin River Power Co., at Prairie du Sac, Wis., has the two specially interesting features of being built upon a deep sand foundation and having the crest of its dam formed by a series of large Tainter gates. The work comprises a power house 329x145 ft. at the west side of the river channel, a hollow concrete dam 1,000 ft. long and an earth embankment extending 1,700 ft. beyond the east end of the dam. Between the power house and the dam are a log chute and a navigation lock 35x170 ft. Fig. 2 is a general plan.

The bed of the Wisconsin River at this point is a deep stratum of sand, changing to heavy gravel and boulders on each side of the channel. Borings made to depths of over 50 ft. failed to show any indications of rock or hard material. The west bank is high and steep, and the power house is built close against it, but low ground on the east side necessitated the construction of the earth embankment.

The power house is of reinforced concrete, supported on round piles spaced 4.5 ft. c. to c. The entire area, 329x145 ft., is inclosed with steel sheetpiling, which is 50 ft. long in the upper line, 15 ft. in the lower line and 40 ft. in the line between the power house and lock. An intermediate line of 15-ft. sheeting was driven about 50 ft. below the upper line.

The draft tubes are of special design, each unit having two separate draft tubes extending to within 25 ft. of the downstream face of the power house. At this point they are joined and continued as one opening. The draft tubes were molded in the concrete, and steel forms were used to produce the desired surface. As a considerable portion of the concrete surrounding the draft tubes was placed during winter weather, the steel forms afforded an excellent opportunity to build fires inside and keep the temperature above freezing point.

The superstructure consists of a brick building with two concrete floors. It is fireproof throughout, the windows having steel frames and sash, with wire-inserted glass. The entire structure rests upon a foundation of sand and is supported on piles; but it is interesting that after two years of operation no settlement cracks are seen.

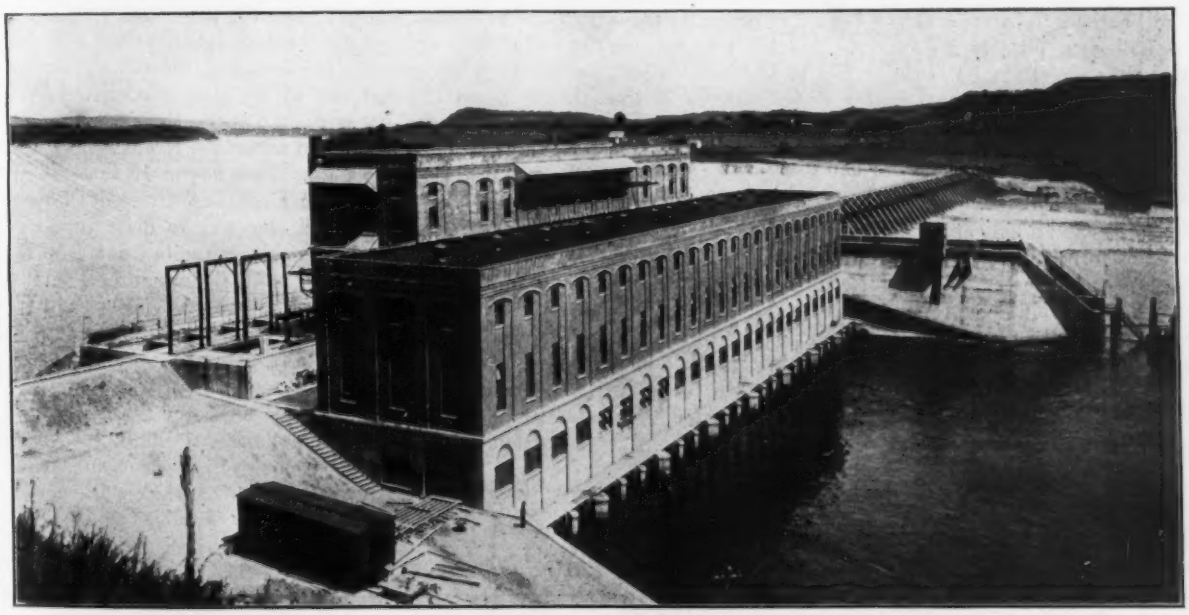


FIG. 1. POWER HOUSE, LOCK AND DAM AT PRAIRIE DU SAC, WIS.

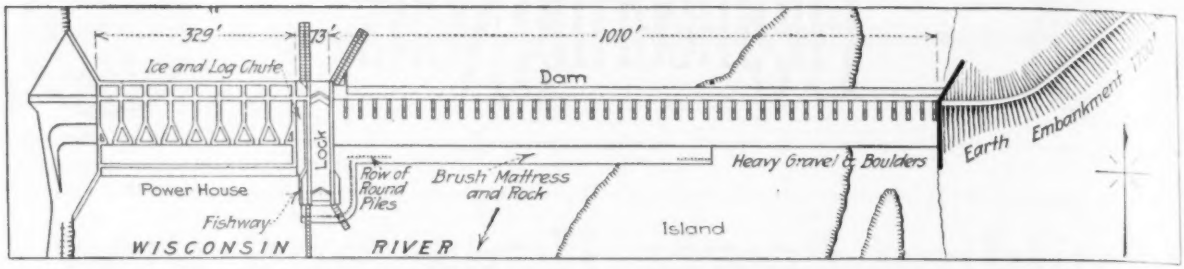


FIG. 2. PLAN OF HYDRO-ELECTRIC PLANT OF THE WISCONSIN RIVER POWER CO., AT PRAIRIE DU SAC, WIS.

The turbine chambers are formed of reinforced concrete, with 3-ft. walls separating the various chambers. A 3-ft. wall also separates the generator room from the penstocks. Water is admitted to each turbine unit through three openings between concrete piers. Each opening is 10.5 ft. wide and is controlled by a double-leaf steel gate. The gates are operated from a gantry crane that may be moved the entire length of the power house.

Each turbine unit consists of four 64-in. wheels on a single line of horizontal shafting. The turbines are designed to operate under a head varying from 22 to 34 ft., and under a maximum head each unit will develop 4,000 hp. The shafts are extended through the bulkhead and connected to 2,500-kw. generators. There will be eight generator units. Six of these are installed, two furnishing 60-cycle and the others 25-cycle current (see Fig. 3).

A transmission line runs to Portage, 24 mi., where it connects with the existing 25-cycle line extending from the Southern Wisconsin Power Co.'s hydro-electric plant at Kilbourn, Wis., to Milwaukee. Another transmission line runs direct from Prairie du Sac to Madison, 28 mi., and two short lines serve half a dozen villages in the neighborhood.

Hollow Dam Founded on Sand

The dam is of the hollow concrete type, with interior buttresses and a long apron on the downstream side. The crest is formed by a row of Tainter gates 14x20 ft. The buttresses are spaced 8 ft. c. to c., and between them are two lines of reinforced-concrete struts. Each third buttress is 4 ft. thick and is carried up as a pier to support the gates and operating platform. The intermediate buttresses are 18 in. thick and are entirely within the dam. All the buttresses have openings 3x6 ft. connected by a concrete-slab footwalk for inspection purposes.

The sand beneath the dam is confined between two lines of steel sheetpiling—a line of 50-ft. sheeting under the upstream face and a line of 30-ft. sheeting under the end of the apron. A filling of boulders and loose rock is placed inside the dam, and a clay and gravel fill is placed above the upstream line of sheeting. Special provision is made against erosion below the end of the concrete apron. A heavy mat 30 ft. wide is laid against the downstream sheeting, at a depth of about 15 ft., and is covered with a fill of heavy rock.

The construction of this work during severe winter weather and with at least one large flood besides other periods of high water was a serious proposition. The dam was completed in January, 1915, and since then it has carried floods with 4 or 5 ft. of water over the crest. Investigation after this showed no material change in the conditions within the dam, and no appreciable settlement or displacement of the rock fill below the apron.

Foundation Piling

The first work was to inclose the power-house site with a coffer-dam and put in the foundation piling and the concrete substructure. The lock and fishway were built next. Then the east end of the dam was undertaken, being built in the dry across the head of the island.

The main part of the dam across the river channel was the last section of the work. This was in 10 to 16 ft. of water, and the flow of the river was diverted through the power house. The first step was to drive the steel sheeting on the downstream side, with its top 2 to 3 ft. below low water level. This is 30 ft. long, except in the heavy gravel at the east end, where its length is 20 ft. Then the 50-ft. steel sheeting on the upstream side was driven, its top being from 3 ft. above to 1 ft. below low water. The latter sheeting was followed closely with timber piles on the inside, these being for the permanent work, but serving also to brace the sheeting.

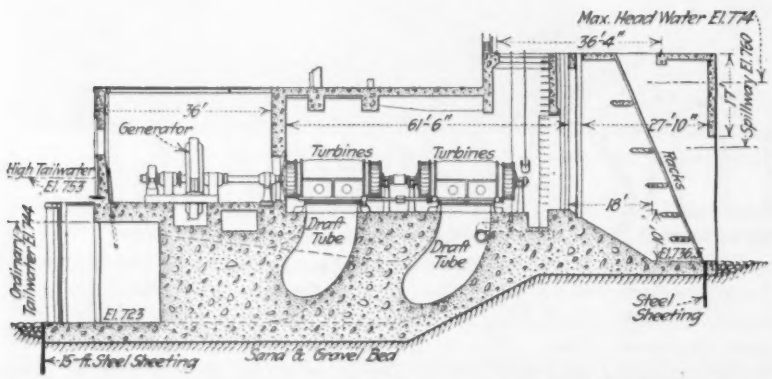


FIG. 3. SECTION THROUGH POWER HOUSE BUILT ON SAND FOUNDATION

The steel sheeting was commenced at both ends, and the closure was made with very little trouble, the sheeting being spread by jacks to admit the closing pile. The next step was to drive the remainder of the timber foundation piles. These were 30 to 35 ft. long in the deep sand and 15 ft. long in the heavy gravel encountered at the ends of the dam. Different designs of interlocking steel sheetpiling were used.

Both the steel and wood piles were driven with steam pile hammers assisted by water jets. It was hard work driving the wood piles in the sand in

spite of the use of water jets. To examine the efficiency of the sheeting, a test pit 12 ft. diameter was formed by driving 20-ft. steel piling. Round piles were driven within this, and the material was then excavated to a depth of 15 ft. The sheeting was found to be in good condition, while the round piles were broomed, having been subjected to unusually hard driving.

The sheeting and foundation piles being in place, a centrifugal pumping plant was used to pump sand into the inclosed space, and on this was dumped loose rock making a 2-ft. mat to protect the fill from wash. Some small rises occurred in the river during this portion of the work, but there was no serious flooding.

Concreting the Dam

The concrete work was then commenced, being done in sections 50 to 60 ft. long, inclosed by sandbag coffer-dams to exclude both the headwater and backwater. The first part of the concreting included the cap over the upstream sheeting, the footings for the buttresses (to a height of about 3 ft.), and the entire width of the apron, including the cap over the downstream sheeting.

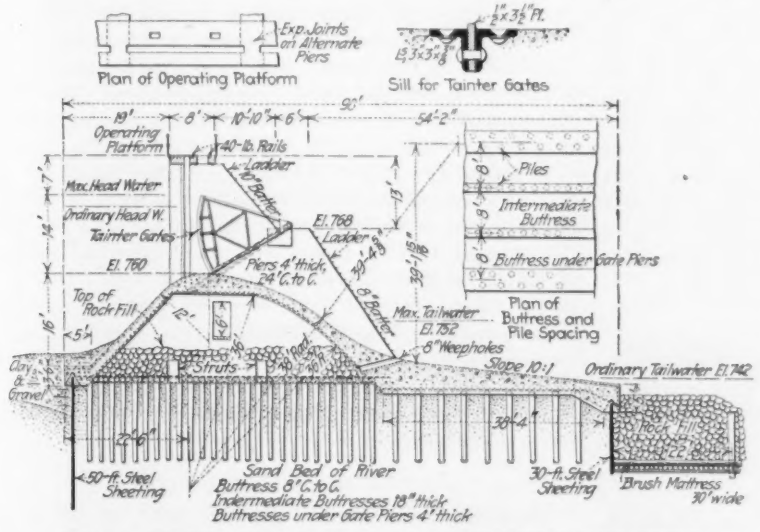


FIG. 4. SECTION THROUGH HOLLOW CONCRETE DAM BUILT ON SAND FOUNDATION: WISCONSIN RIVER POWER CO.

This being completed for the length of the dam, sections of similar length were taken and the buttresses carried up to the full height of the dam. Then the upstream face or blanket was placed, next the downstream face, and finally the crown. For each of these several stages the work was done in lengths of 50 to 60 ft. The next stage was to carry up the piers to full height and connect them with the concrete walk.

Before closing the dam by placing the top, or crown, a 3-ft. bed of boulders and loose rock was placed inside to increase the stability and to weight the inclosed sand fill of the foundation. Finally clay and gravel was filled in along the upstream face, where the material had been washed out around the top of the sheeting. This will remain undisturbed and may be increased somewhat by sediment, but there is so little current in the pool that this accretion will be slight. The downstream protection of the apron is described later.

Dovetailed grooves form bonds in the vertical joints between different sections of the concrete work. In building up the buttresses the top surface, for the horizontal joints, was made with rectangular recesses or projections. The latter had the advantage of not tending to collect mud or dirt, which would have to be cleaned out of recesses before starting the next section of the buttress. Wood forms were used for all the work except the upper part of the piers and the bridge or platform between the piers. The piers have grooves for stop-logs, and timbers were placed in these to raise the head 5 or 6 ft. until the gates were installed.

The bridge or working platform is 1,000 ft. long, and in order to provide for expansion and contraction movements it was made in lengths covering two spans. The piers were carried up to full height, and the platform was built after the concrete had set. Each two-span length has its ends resting on iron base-plates on the piers, but no attempt is made to prevent a bond over the middle pier.

The concrete was made with pit gravel. This was not washed or graded, but was passed over a bar screen with 3-in. openings in order to remove the larger stones, which were used afterward for the fill inside the dam. The mix was 1 : 7 for mass concrete, 1 : 6 for reinforced concrete, and 1 : 5 for some of the small pieces of work. Much of the concreting was done during the winter. The water was heated, but no salt was used, and the gravel was heated by coils of steam pipes. The 50-ft. section of work was covered by canvas sheets about 30 ft. square, supported on frames of 2x6-in. timbers, and salamanders were kept burning on the inside.

The gravel pit was ¾-mi. from the east end of the dam, and the gravel was loaded by a Thew steam shovel into 3-yd. side-dump cars on tracks of 3-ft. gage. These cars were electrically operated, as noted later. The concrete mixing plant was located at the east end of the hollow dam and had two Cube mixers of 1¼-yd. capacity. The gravel cars ascended an inclined trestle and dumped automatically into a 12-yd. hopper. From this the gravel was fed to a measuring hopper (for one batch). This was at the level of the cement storage house, and the cement was placed in the hopper, which then delivered the charge by a chute to the mixer. The concrete was discharged into an elevator bucket, which dumped into a hopper (with valves) in a tower from which it was spouted to the concrete cars. In this way the work proceeded very systematically, there being one batch in the mixer, one in the elevator bucket and a third in the tower hopper.

When the 12-yd. hopper was full, the cars dumped the gravel upon a stockpile, from which it was delivered to the hopper as required by a derrick and bucket located near-by.

The concrete cars were steel hoppers of 1¼-yd. capacity, with a discharge chute in one side, near the bottom. These were handled in 3-car trains, or 4-car trains when both mixers were working. Each train was handled by a motor car with 15-hp. motor.

The trestle across the upstream side of the dam served for the concrete trains, passing places being shifted as required. The cars on the trestle dumped the concrete into steel chutes. These were of V-section with rounded bottom, as in this form there is less tendency of the coarse material to segregate and run along the bottom of the chute than in chutes of semicircular section.

The general storage yard was on the west bank, material being brought in on cars over a spur track a mile in length. From this yard all material was distributed by the cars of the remote-control system.

Electric Industrial Railway

The gravel cars and concrete trains were operated on the Woodford remote-control system (see *Engineering News*, Oct. 21, 1909). Each gravel car (and similar car acting as a locomotive for the concrete trains) had a 15-hp. motor. On the line from the gravel pit there were some short grades of 6 to 7%. In descending the grade, a trip caused the motor to act as a generator, returning current to the line and thus serving to brake the car. At the foot of the grade another trip restored the apparatus to its normal working condition.

An operator in a tower at the mixer controlled the movement of the gravel cars and concrete trains within a certain distance. Another tower at the gravel pit controlled the terminal movements of the cars, and a third tower at an intermediate point controlled the movements between the pit and the mixer plant. A fourth tower near the west end of the dam provided for control of the concreting trains when the work was too far distant for convenient control by the operator at the east end.

Navigation Lock

The river being nominally navigable, the War Department required the provision of a lock. This is 35x170 ft., with a lift that reaches the exceptionally high maximum of 34 ft. This is all built of the 1 : 7 concrete. The gates are of steel, of the horizontally braced type, operated by steel arms driven by an electric motor.

During the construction of the work notice was received from the Government authorities to provide for the passage of a fleet of steel barges that had been built at Green Bay, Wis. At this time the larger part of the dam was above water and the river was at a high stage, with the greater part of the flow going through the power house, while the gap between the completed work and the lock had been closed with stop-logs and steel beams. The passage was delayed until the water had subsided a little, and the stop-logs and beams were then pulled out. This gave a passage 35 ft. wide, in which the water had a drop of about 6 ft. For running the dam each barge had four men handling two sweeps, or long oars, one at each end. All made the passage in safety.

Brush Mattress and Rock Fill

To prevent wash and erosion at the end of the concrete apron by eddies and backlash, a brush mattress 30 ft. wide is placed beyond the apron and covered with heavy rock filling. The river bed was excavated and the mattress placed 10 to 15 ft. below the top of the concrete.

The mattress is composed of mats about 30x31 ft. Local willows were cut and put up in 9- to 12-in. bundles, tied with No. 10 wire. These were hauled to the mattress-making platform, having inclined skids 5 ft. apart. Across the skids were laid poles 5 ft. apart, and the bundles or fascines were placed upon these, followed by a second layer of bundles at right angles to the first. A row of poles 5 ft. apart was placed on top and the whole mass wired together tightly. A wire selvage was also formed around the edges.

The mattresses were launched from the skids and floated into position. The sand and gravel had been excavated to a depth of 10 to 15 ft., and the mats were sunk in place by stone thrown from barges. Near the downstream side a continuous line of 30-ft. round piles was driven through the mat. The piles stood about 8 to 10 ft. above the mattress and served to retain the fill of large loose rock which was dumped upon the mattress to a level with the top of the concrete apron. On the heavy gravel at the east the mattress and the line of piling were omitted, but the rock fill was continued.

Earth Embankment

Beyond the east end of the concrete dam extends an earth fill or embankment 1,700 ft. long and from 1 ft. to 25 ft. high. The top width is 8 ft., with side slopes of 1 on 2. For the first 100 ft. from the dam this has a cutoff of 10-ft. sheetpiling, with wood sheeting extending within 10 ft. of the top of the embankment. Beyond this the cutoff is of wood sheeting 10 ft. deep except that near the extreme end it is replaced with a 3-ft. puddle wall 5 ft. deep. Where the steel and wood sheeting are used in combination, the lower end of the latter is driven about a foot below the top of the former and on the downstream side. A line of clay puddle is then placed along the upstream side of this horizontal joint.

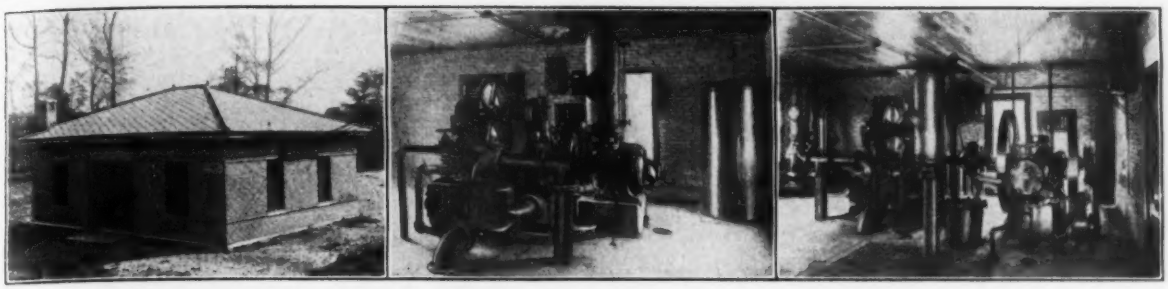
The fill is of earth and was placed partly by dump wagons and partly by small dump cars. A considerable portion was placed also by wheelbarrows, this being done to keep the men employed and thus maintain the organization at times when other work was stopped by high water. The upstream slope is paved with riprap.

Engineers and Contractors

The plant was designed by and built under the direction of D. W. Mead and C. V. Seastone, of Madison, Wis., as Chief Engineers for the Wisconsin River Power Co. R. G. Walker was Resident Engineer in charge of the construction.

The contractor for the entire construction of the dam, power house and lock, including the placing of the steel Tainter gates and the lock gates, was James O. Heyworth, of Chicago. The Tainter gates were built by the Lakeside Bridge and Steel Co., of North Milwaukee, Wis. The steel gates for the lock were built by the Federal Bridge Co., of Waukesha, Wis. The turbines and generators were built by the Allis-Chalmers Co., of Milwaukee, Wis.

Machines for Spreading Rock Dust have been developed by the Bureau of Mines. The experiments of the bureau have shown that by spreading a layer of rock dust over the coal dust in bituminous coal mines the risk of dust explosions is reduced. In the first experiments with rock dust finely pulverized limestone was used, 75% passing a 100-mesh sieve. Later experiments showed that rock ground by a hammer crusher sufficiently fine to pass a $\frac{1}{16}$-in. slotted screen was practically as efficient as the fine dust and much less costly to prepare. In the original treatment of mine passages the rock dust was spread by hand, but after a time a new layer of coal dust settles over the rock dust and renewal of the rock layer is necessary. This can best be done by a blowing machine. A machine developed by the Bureau of Mines for this work uses air from a pressure blower at about 2 lb. per sq.in. pressure.



FIGS. 1 TO 3. EXTERIOR AND INTERIOR OF THE MILLTOWN, N. J., PUMPING STATION

Automatic Water-Works for a Small Town

By Clyde Potts*

The increase in the population of the borough of Milltown, N. J., from 560 in 1900 to 2,500 in 1912 found the town with neither water-works nor sewers. Water was taken from shallow wells, and outdoor privies were in common use. Plans were drawn by the writer for complete water-supply and sanitary-sewerage systems. The following notes on the water-works should be of interest to engineers dealing with small-town problems, since the service is by pumping, but is entirely automatic and requires only a small amount of attention.

About 5.6 mi. of pipe—all cast iron of hub-and-spigot pattern, American Water-Works Association Class B—was required. The sizes were as follows: 4 in., 2,482 ft.; 6 in., 18,053 ft.; 8 in., 1,912 ft.; 10 in., 7,223 ft. The cost of this system complete, including 85 valves and 52 hydrants, was $23,922, making $4,270 per mile.

The supply consists of a filter gallery laid along the edge of the hill and leading to a large storage well. In addition to the filter gallery two wells 6 ft. in diameter, made of interlocking steel sheet piling, were driven through the gravel to a shaly rock. These wells also flow into the storage well.

The filter gallery is some 500 ft. long, is 6 ft. wide and 6 ft. deep. The sides are built of hollow tile along the lower 4 ft. The groundwater enters the filter gallery through the sides and through the bottom, coming up through the gravel. This gallery has a reinforced-concrete roof and is provided with manholes at various points to permit the attendant to enter it for the purpose of cleaning. The storage well is 30 ft. in diameter and 18 ft. deep. Water is taken from this storage well by a Deane 10x10-in. triplex pump operated by an electric motor. A similar gas-engine unit is installed (Fig. 3). The water is pumped through a 10-in. pipe laid through the main street of the borough to a 90,000-gal. tank elevated on a 75-ft. tower.

The electric pump is automatic in its operation, the electric motor being controlled by a water-pressure gage on a special electric switchboard. The electric energy used is from the town lighting mains—two-phase alternating current at 60 cycles and 220 volts.

When the water in the standpipe falls below a certain point, the reduced pressure on the pressure gage at the pumping station closes a switch, which starts the electric pump in operation, and water is pumped from the storage well into the standpipe until it reaches a predetermined level, when the pressure gage cuts off the current at the switchboard and the pump stops. The control secured by this pressure gage is so delicate that the opening of a hydrant at any place in the main part of the borough reduces the pressure a sufficient amount so that the electric pump starts. In the event of a fire in the borough not only is the water in the standpipe available, but the opening of a hydrant by the firemen immediately starts the electric pump at the pumping station, and the entire 90,000 gal. of water stored in the storage well also becomes available through direct pumping.

The cost of the wells and supply was $6,200. The cost of the pumping station, including the electrically driven pump and gas-engine auxiliary, was $7,650; and of the standpipe and tower complete, $5,800. With the cost of the pipe system before mentioned, this makes the total construction cost of the water system $43,572.

The plant is automatic in its operation and requires very little attention. The superintendent of the water plant, who also has charge of the sewer system, visits the plant daily for purposes of inspection and oiling. The

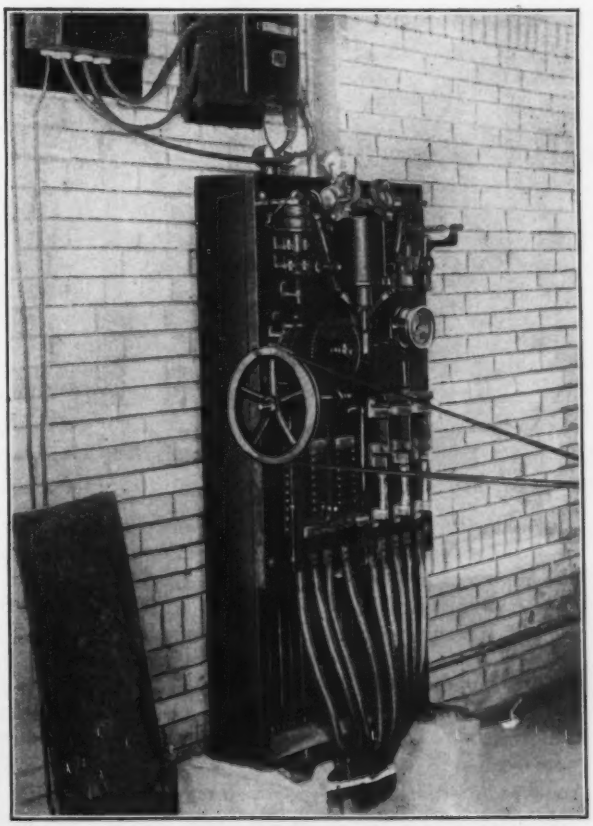


FIG. 4. AUTOMATIC ELECTRIC PRESSURE REGULATOR

*Consulting Engineer, 30 Church St., New York City.

cost of pumping since the plant has been in operation, from Apr. 1, 1915, has been a trifle under $14 per million gallons, exclusive of superintendence.

Since the most unusual feature of this plant is its automatic starting and stopping device, a more detailed description of this controller may be of interest. It is known as the Whittingham motor-driven type, having a double-pole magnetic main-line switch, double-pole no-volt relay sylphon-pilot pressure regulator, three-pole single-throw 200-amp. knife switch and fuses, pressure gage and a switch to permit hand operation independently of the automatic control.

The device is distinctive in that, while it is of the current-limiting type and absolutely prevents the motor from being started on an overload, it also provides for cutting out the resistance if the motor starts and in this respect is unlike series current-limiting controller devices. The resistance, instead of being cut out as is customary on a comparatively few steps, is cut out in 24 graduated steps at an adjustable speed, which once set is unchangeable, obtained directly from the motor through a worm gear magnetically clutched to the resistance arm, resulting in absolute freedom from arcing and from changes in timing. The resistance is of a sand-packed tubular type, mounted below the line of panel, leaving all back wiring exposed. This back wiring is of fireproof insulation, with soldered lugs at all connecting points. The period of cutting out of the resistance, or reaching full speed, is considerably over 1 min. in this case, which is highly desirable on a triplex pumping engine of this size, where it is especially needed to keep down the inrush of current.

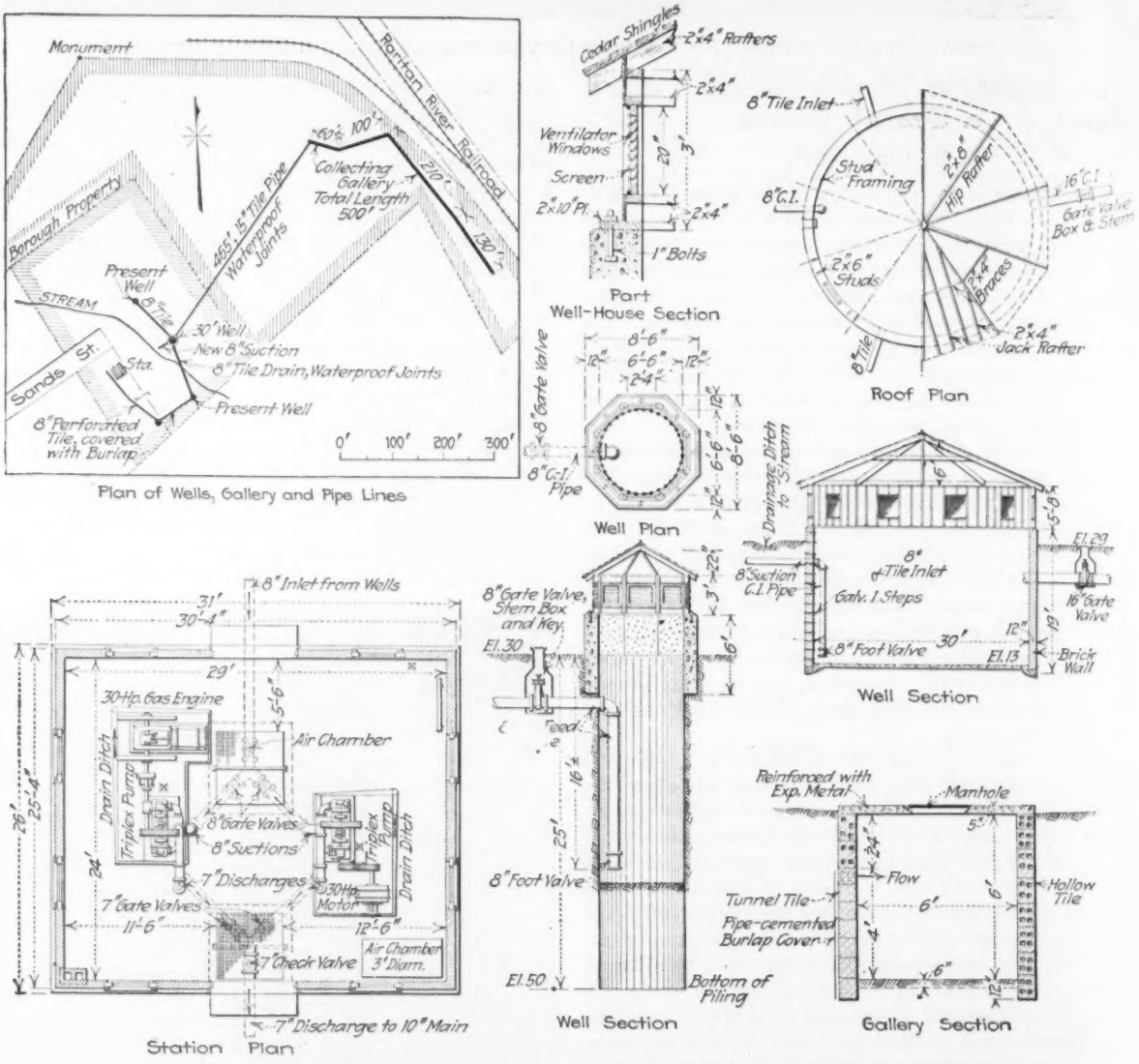


FIG. 5. DETAILS OF MILLTOWN FILTER GALLERY, WELLS AND PUMPING STATION

At full motor speed but two magnets are energized, and this detail differs materially from most controlling devices for the purpose. There is absolute freedom from noise and heating, such as are frequently encountered where a large number of solenoids are called upon to cut out the resistance in successive steps.

This controller not only provides protection against an overload, but also against the blowing out of a fuse, as the relay operated by the pilot-pressure regulator is across one phase, while the magnetic main-line switch is across the other. Therefore, it would be impossible to close the main-line switch, which is fed through the relay contacts, if either phase opens.

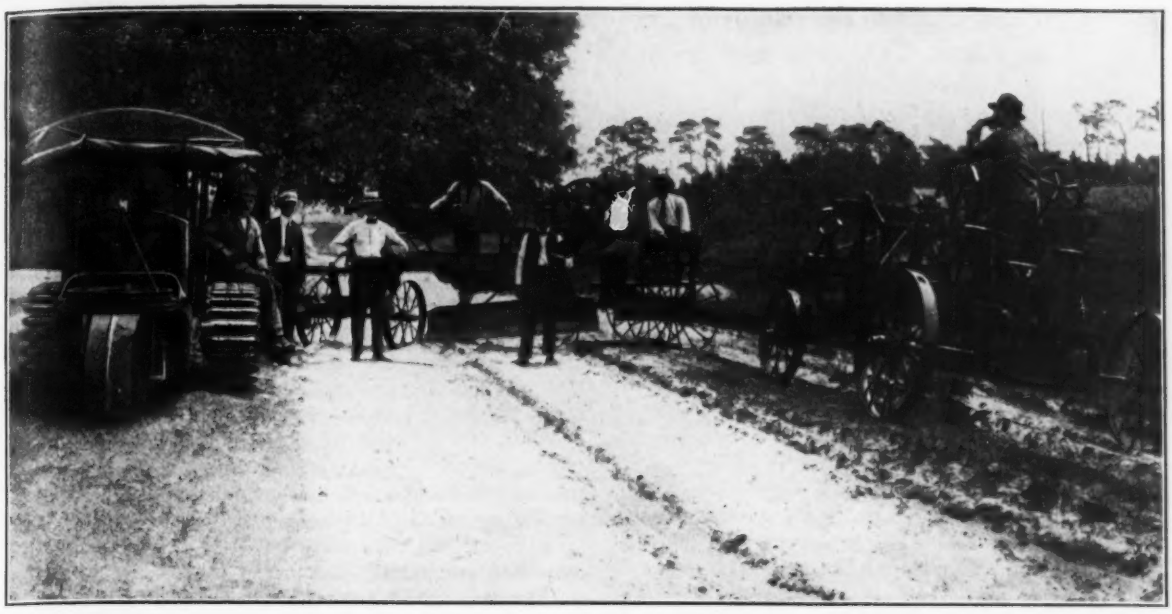


FIG. 1. VERY SANDY ROAD ON WHICH GRADERS ARE HAULED BY TRACTOR

In service the regulator is intended to stop the pump at a certain predetermined level about 10 or 12 ft. above the low level at which it starts; but owing to the frictional head, it is found that the opening of a hydrant will start the pump at any time, although the tank may be completely filled. This eliminates the necessity for the use of a hand-operated means for starting the pump independently of the fall in pressure and results in the pump starting immediately in case of fire, thus materially increasing the reserve capacity available in the storage tank.

The contractor for the water-works was the Suburban Engineering Co., New York City; the automatic controller was built by the Automatic Switch Co., New York City.

Tractor with Ball Bearings in Endless Tread

The "Yuba Champion" tractor, having three wheels—the two rear wheels being of the endless-track or caterpillar type—was developed about a year ago by the Good Roads Machinery Co., Kennett Square, Penn. The machine is built in two models. Model 12 develops 20 hp. as a stationary plant, and 12 hp. at the drawbar. It is 14 ft. 7 in. by 69 in. in plan by 57 in. high and can be turned in a width of 15 ft. It has two speeds: 3¼ mi. per hr., and 2 mi. per hr. The total weight is 7,600 lb., of which 6,000 lb. is on the rear wheels. The motor horsepower is 35 to 40. Model 18 develops 25 hp. as a stationary plant, and 18 hp. at the drawbar. It can be turned in a space 15½ ft. wide. Its speeds are ¼ mi. higher than in the case of the other model. The total weight is 8,900 lb., with 7,400 lb. on rear wheels. The motor horsepower is 55 to 60.

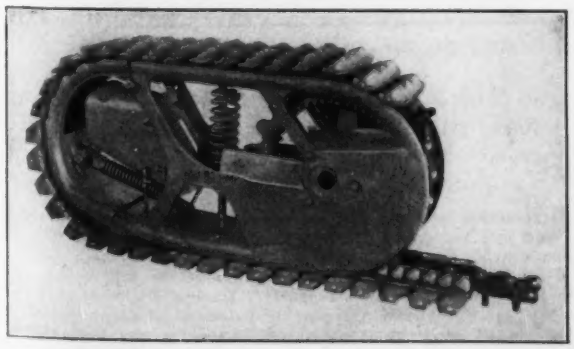


FIG. 2. BALL-BEARING CONTINUOUS TREAD

The distinctive feature of this tractor is the ball-tread traction. The endless track runs on two sets of ball bearings. The maximum wear comes on the balls, which are easily replaceable. In addition to the low friction of this type of bearing, the track is not subject to being thrown off even on side-hill work. The tread can be extended by angles bolted to each alternate tread shoe, which widens the track to 30 in. In Model 12 the normal tread width is 15 in. and the bearing area is 1,080 sq.in., the pressure per square inch on the tread being 5½ lb. In Model 18 the tread width is 17 in., the bearing area 1,632 sq.in., and the pressure 4½ lb. per sq.in. The tread links are of manganese steel.

A distinctive feature is the use of an independent clutch on each tread, which enables the operator to reverse one tread while the other is moving forward, making very short turns possible.

Water Levels of Ocean and Gulf—The United States Coast and Geodetic Survey has recently undertaken to determine the difference in the mean level of the water surfaces of the Atlantic Ocean and the Gulf of Mexico. A representative of the bureau has been sent to Florida to carry a line of precise levels between the tide gages at Fernandina and St. Augustine, on the Atlantic Coast, across the Florida peninsula to tide gages on the Gulf coast. This work should clear up the controversy as to which body of water is at the higher elevation. Another benefit that will result from this line of precise levels will be the establishment of many bench marks of a substantial character whose elevations above sea level will be determined. These can be used by surveyors and engineers who work in the territory crossed by this line of levels.

The Slide-Rule Replaced by a New Computer

By Yu Wang*

Based upon the behavior of a pair of movable parallel lines, a new computing device has come into existence. It has various forms, among them the "Z" Computer, the Computing Board and the Wang Precision Computer.

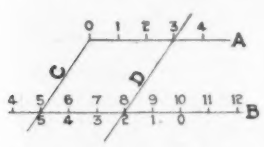
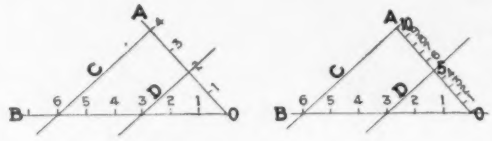


FIG. 1. ADDITION OR SUBTRACTION BY PARALLEL SCALES



FIGS. 2 AND 3. PRINCIPLE OF MULTIPLICATION AND DIVISION IN TWO FORMS

The methods by which these instruments are able to obtain mathematical results are nonlogarithmic; consequently, the instruments do entirely away with the slide, the runner and the movement of scales.

The principle of the instrument is very interesting. One of the parallel lines is to swing over scales, while the other is to move parallel to the first by separation of a parallel ruler. When the movable parallel lines operate on parallel scales, as shown in Fig. 1, addition or subtraction takes place. When line C is swung to point 5 on scale B, line D will indicate 8 if moved to point 3 on scale A and kept parallel to C. Thus we obtain $5 + 3 = 8$, as shown. But if scale B is enumerated reversely, as shown under the line, the whole process becomes subtraction and the figure 2 instead of figure 8 is read; $5 - 3 = 2$, as shown.

When the movable parallel lines operate on a pair of intersecting scales started from the same origin, they will cut ratios and proportions, as in Fig. 2. If line C cuts 6 on scale B and 4 on scale A and the movable line D, parallel to C, is moved to cut 2 on scale A, a proportion will take place; thus, $4:6::2:3$. But if we hinge line C at 10 instead of at 4 (Fig. 3), the proportion becomes either multiplication or division, because $4:6::2:3$ is changed into $10:6::5:3$, or $5 \times 6 = 30$, or $30 \div 6 = 5$.

Again, if we multiply or divide the enumeration on scale B by a common number, the same theory will hold true while the number of figures in the reading is either increased or decreased. For instance, if we multiply scale B by 5 so that the point 6 will be enumerated 30 from the origin, the point 3 will be naturally enumerated 15, and more figures are obtained in the reading. By such multiplication of scales a precision computer is made, to compute more figures than the ordinary slide-rule, three or four figures by scale and four or five figures including estimation.

Besides these results the chief advantages of the instrument are its low cost and the possibility by clever combination of scales to facilitate the calculation of complex problems, eliminating settings and readings, which the slide-rule in many cases cannot do. The Computing Board (Fig. 4), made specially for such purpose, has logarithmic and trigonometric scales, scales of powers and roots, etc., besides the simple addition and multiplication scales.

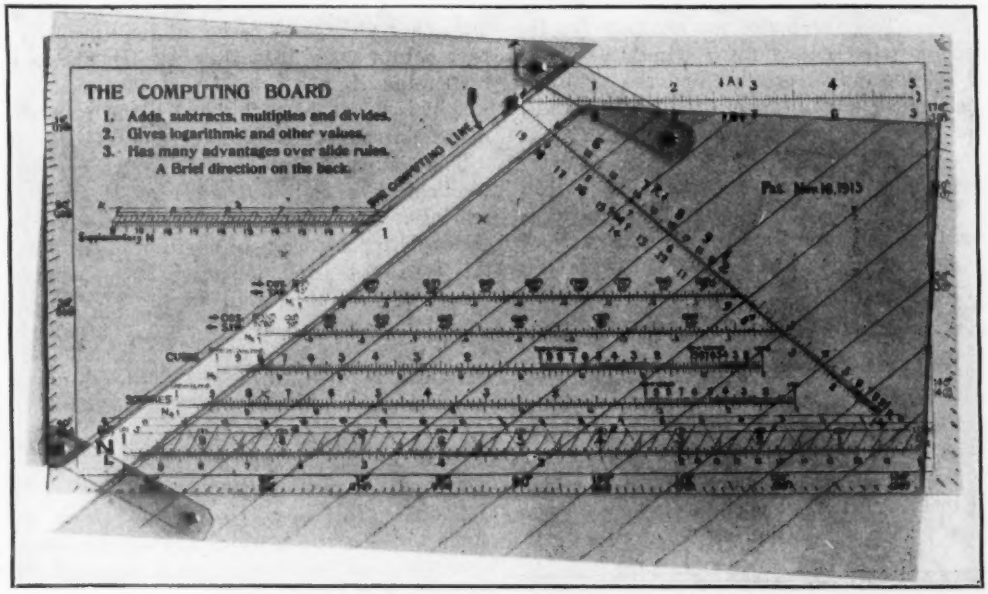

THE COMPUTING BOARD
1. Adds, subtracts, multiplies and divides.
2. Gives logarithmic and other values.
3. Has many advantages over slide rules.
A Brief direction on the back.

FIG. 4. THE WANG COMPUTING BOARD

This kind of instrument was invented by the writer, a Chinese, whose primary patent on such instruments was granted Nov. 16, 1915.

*President of the Scientific Devices Co., 2 Rector St., New York City, and inventor of mathematical instruments.

Extraction of Grease from Sewage at Bradford, England, by the use of niter cake instead of sulphuric acid is under consideration as a war measure. A visit to the sewage works was made by representatives of the explosives department of the Ministry of Munition recently. During the visit it was stated that the munition department desired to encourage the adoption of niter cake as a substitute for sulphuric acid wherever possible, the niter cake to be shipped from the Government factories to places of use.

Concrete-Capped Sheetpile Dam for Erie Canal

By Emile Low*

As noted in *Engineering News*, Jan. 13, 1916, p. 94, the eastern end and part of the sluiceway of the New York State dam across Tonawanda Creek, in Tonawanda, N. Y., was washed out on Jan. 7, 1916, by high water. As this dam regulates the western or the Lake Erie level (Buffalo-Lockport) of the Erie Canal, it was necessary to make immediate repairs, in order not to interfere with the regular canal navigation, which usually opens May 15 of each year. It was decided that a new dam, the essential features to be two rows of steel sheetpiling, capped with concrete, would be the quickest method of construction, as well as the most economical.

To give the least interference while building, and to avoid obstructions and débris of the old dam, the location of the new dam was fixed a short distance above the old one, which was a timber structure, originally built before 1825. It was first proposed to build the new dam on a curve, with a radius of about 300 ft., but this was modified before construction and it was built in two straight parts corresponding to the tangents of the original curve and forming an angle in the center of the stream.

The dam as built consists of two parallel rows of Lackawanna straight-web steel sheetpiling driven 12 ft. apart, the length of the piling ranging from 25 to 35 ft. The tops of the piling are secured against spreading by a reinforced-concrete top, and against overturning by a diagonal system of bracing, consisting of 1¼-in. round steel rods which also tend to stiffen the structure. It is further strengthened by riprap and gravel backing and filling.

The rods leading from the top of the upper row of sheetpiling to the lower row are spaced 10 ft. c. to c., while the reverse rods are spaced 5 ft. c. to c., each rod being of two pieces fitted with a turnbuckle for regulation. The lower ends of the rods were secured to the piling by a nut with a ½x5-in. washer. As the point of connection was from 8 to 10 ft. below water level, the rods were attached to the piling before this point was driven below water level and the driving continued with the rod in place. The upper piece of the rod with its bent end was then hooked into a drilled hole and the rods adjusted for length by the turnbuckle.

FIG. 2. LOOKING NORTH ACROSS NEARLY COMPLETED DAM

The space between the two rows of sheetpiling was filled with Niagara River gravel and sand mixed and a concrete cap placed which formed the crest of the dam. The original plan contemplated a cap with a convex top and straight bottom. This was modified by making the top level and the bottom concave, in other words, turning it upside down, the area of the reversed section remaining about the same. The dam being a submerged weir, the change gave a lower crest elevation and a consequently greater discharge, which in flood times reaches 21,000 sec.-ft. The change was also necessary on account of the water level, the elevation of which made the original construction impossible except inside of a water-tight cofferdam. The ends of the dam impinge against bulkheads built of Lackawanna steel sheetpiling, the ends of which may be noticed in the foreground in the view in Fig. 2.

*745 Lafayette Ave., Buffalo, N. Y.

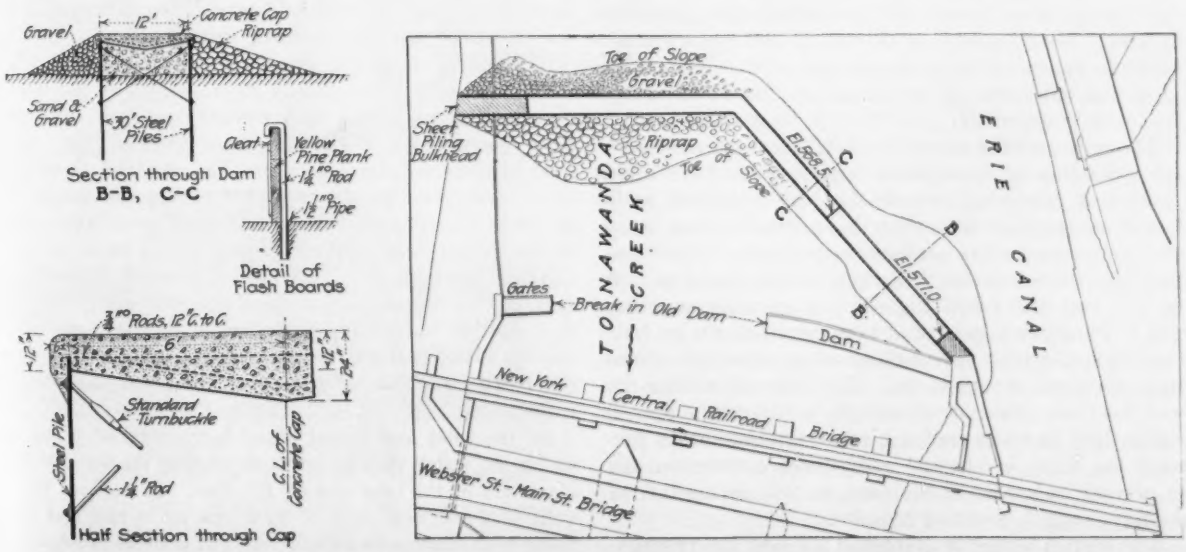


FIG. 1. DETAILS OF DAM ACROSS TONAWANDA CREEK AT TONAWANDA, N. Y.

The greater part of the crest of the dam is built to El. 568.5 ft., a short stretch at the west end being 571.0 ft. or 2.5 ft. higher. The low portion of the dam is arranged for flashboards in 12-ft. lengths, 30 in. high and formed of three yellow-pine planks each 2 in. thick and 10 in. wide, with three 1x4-in. cleats in each section. The flashboards are held in place by 1¼-in. round steel rods, resting in 1½-in. pipes, 12 in. long, previously set in the concrete crest, flush with the top surface. The tops of the rods are bent to hook shape, which when driven down over the top plank made a snug fit, holding the flashboards securely in place.

The lower side of the dam is riprapped with stone and the upper side with gravel to give additional strength. The material at the site is generally clay, some 20 ft. deep, below which is hardpan of varying hardness. The steel sheetpiling was driven by the usual floating pile-driver, the piles driving easily through the clay and relatively harder in the hardpan.

The engineer's estimate for the work was $36,052.81 and the contractor's itemized bid as follows:

Item	Quantity			
1	0.46	M ft. sawed yellow-pine lumber...	$60.00 =	$27.60
2	1	M ft. contingent sawed lumber....	1.00 =	1.00
3	3,036	cu.yd. gravel filling.....	1.34 =	4,068.24
4	20,065	sq.ft. steel sheetpiling.....	1.00 =	20,065.00
5	203	cu.yd. second class concrete.....	8.00 =	1,624.00
6	6,628	lb. structural steel.....	.07 =	463.96
7	4,940	lb. metal reinforcement.....	.05 =	247.00
8	300	cutting steel sheetpiling.....	.25 =	75.00
9	1,235	cu.yd. third class riprap.....	3.00 =	3,705.00
	Total			$30,276.80

The contractor for the work was the Henry P. Burgard Co., of Buffalo, N. Y. The piling was driven by Charles A. Dennis, of the same city. The work was in charge of the department of the State Engineer and that of the Superintendent of Public Works, under the immediate direction of B. E. Failing, Resident Engineer, and O. L. Burdett, Assistant Engineer.

Venturi Meter Succeeds in Irrigation

The great increase in areas placed under irrigation and the consequent rise in value of irrigation water have brought an insistent demand for accurate, but still rugged and inexpensive, devices for measuring the quantities applied. The simplicity of the well-known venturi meter long ago led to various proposals to use it in measuring irrigation water, but the expense of the automatic recording devices apparently precluded its immediate use.

The weir and the current meter have been used with few difficulties in determining large flows in main canal systems or important laterals, but the important problem of economically measuring the smaller amounts delivered to the farmer has not been easily solved. It is essential that the successful irrigation meter should be low in first cost and entail little or no operating expense; this is in addition to such obvious requirements as freedom from clogging, few working parts, automatic operation, sustained accuracy, etc. For farmers' ditches the weir has three serious disadvantages in requiring a considerable drop in water surfaces, constant attention to preserve the depth of channel and stream contraction and to prevent backwater at the crest, as well as the lack of a cheap, rugged, accurate recorder.

The venturi naturally overcomes the first two troubles: The drop required is not over 4 in. at full capacity and less at lower velocities; the waterway is perfectly smooth and unobstructed, so that silt and litter are swept along. Only the larger obstructions have to be guarded against—such as should be removed from the canal anyway. The only feature that has required any considerable study has been the recorder. Very satisfactory recorders were already developed for other services where the venturi meter was employed, but the rough conditions prevailing in irrigation work required unusual simplicity and ruggedness. The limitation of cost for the complete meter probably was the greatest obstacle to be overcome.

Studies were early made by F. N. Connet, Chief Engineer of the Builders Iron Foundry, Providence, R. I. (which concern has manufactured the venturi meter since its first appearance on the market). The first of Mr. Connet's devices appeared in 1908, but the development of the irrigation meter was not pushed for several years. The first service installation was made in 1913 for the United States Reclamation Service in Salt River Valley, Arizona. Improvement has continued, and much of the credit for the commercial development of the present meter is due to Howard S. Reed, of Phoenix, Ariz., who was in charge

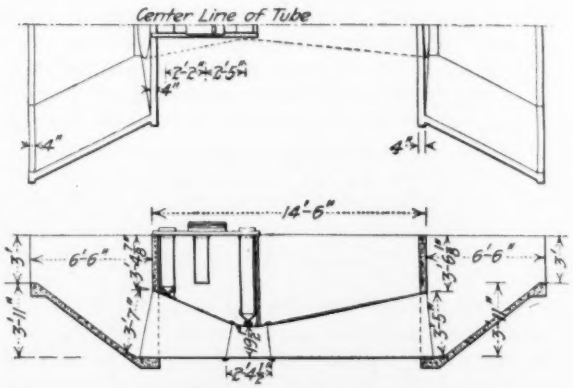


FIG. 1. HALF PLAN AND SECTION; 20-SEC.-FT. VENTURI IRRIGATION METER

of the development of water-measuring devices on this project. At that time the Reclamation Service was anxious to secure a good automatic meter for main laterals, distributaries and farmers' turnouts.

The venturi irrigation meter comprises the usual tube and the recorder. Necessarily the tube follows the usual construction in having two conical ends, of different taper, connected by a short length of straight pipe. The most obvious difference between this tube and those for other services is that the axes of the cones and throat do not form a continuous tangent. Instead, the alignment is by the bottom element of all three, as shown in the accompanying illustrations. This design presents several advantages for installation under the conditions prevailing in irrigation work. The tubes are of cast iron and galvanized plate, concrete, or wood staves—whichever material is most suitable for given conditions and most easily transported.

At the inlet and throat stand large vertical pipes in which the water rises to levels depending on the relative diameters of the tube and on the flow. In each of these wells is a spherical float of such size as to rise and fall freely with changes in water levels, but without much horizontal movement. The vertical travel of these floats is

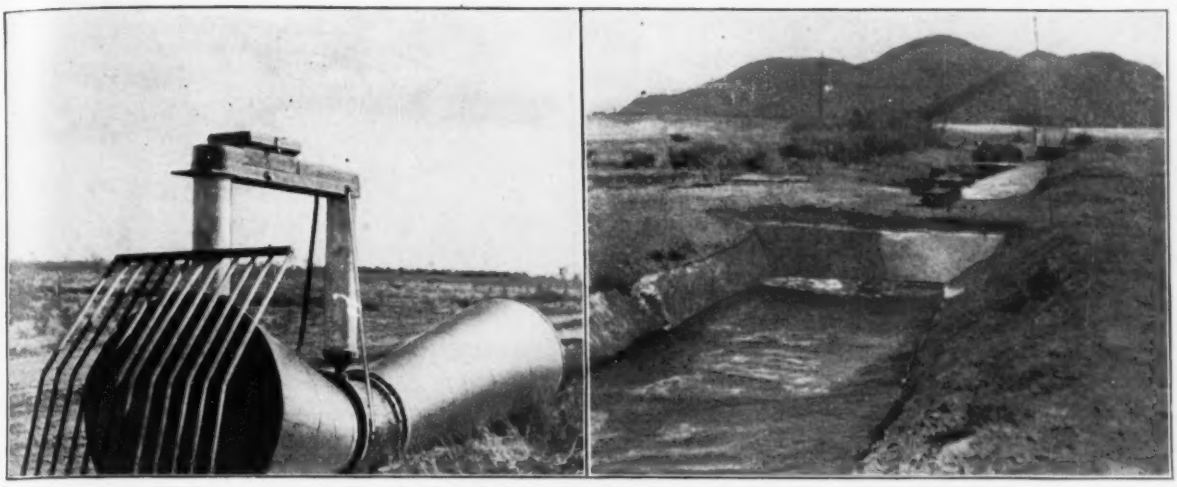


FIG. 2. A 30-SEC.-FT. VENTURI METER BEFORE AND AFTER INSTALLATION
Left—Upstream end. Right—Outlet end. Salt River project

transmitted by counterweighted cables to shafts in the recording mechanism.

The recorder, really the key to the practicability of the field venturi irrigation meter, is made largely of bronze and aluminum parts inside of a heavy cast-iron case, with a hinged cover that can be fastened with a padlock. In the cover is a glazed peep hole by which the rate of flow and part of the chart may be observed. The cables from the floats pass around sheaves and are counterweighted.

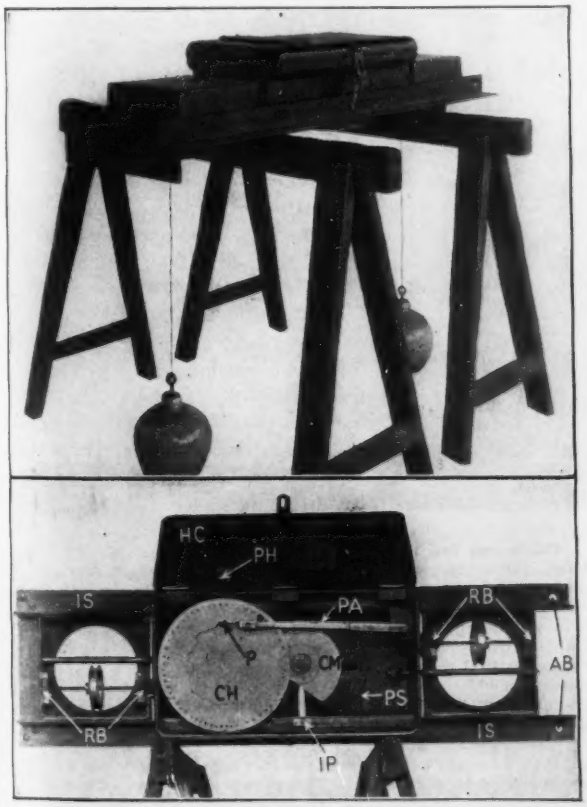


FIG. 3. RECORDER FOR VENTURI IRRIGATION METER
IS, angle-iron supports; AB, anchor-bolt holes; RB, roller bearings of float shafts; HC, hinged cover; PH, glazed peek hole; P, pen; PA, pen arm; CH, chart; CM, cam; IP, fixed index; PS, pen spring

Movements of the sheave shafts are carried to the center of the case by shaft extensions and combined through differential and bevel gears so that the rotation of a cam is made always proportional to the difference of water level in the inlet and throat wells. The outline of this cam is such that its radii are proportional to flow for various inlet-throat head differences. The pen arm bears on the cam edge through a roller and is held against the cam by a long helical spring. The pen-arm shaft bearings are held in a tube that drops into a drilled hole in the cast-iron housing. The cam is graduated, and a fixed index on the case enables checking the pen and chart positions. The float-sheave shafts rest on roller bearings in open brackets, from which they can be easily lifted. A 12-in. circular chart is revolved under the pen arm by clockwork, a new chart being required only once a week. The chart divisions cover 2 hr.; day and night hours are distinguished by shading.

Any size of venturi tube, from 10- to 125-sec.-ft. capacity, can be used with the same recorder. All that is necessary is to substitute longer angle irons and shaft connections from the well boxes to the register case. The recording apparatus is supported free of the float wells; at the upstream end the angles are fastened to the inlet crosswall while the downstream ends are supported on a wooden strut, or iron braces, resting on the throat piece of the meter tube.

The accuracy of a 15-sec.-ft. venturi meter was tested by a board of engineers appointed by the project manager of the Salt River Project at the request of the Salt River Valley Water Users' Association. Twelve separate determinations were made at capacities ranging from 2.96 to 16.86 sec.-ft. in a period of about two months. The venturi figures compared with those from a Price current meter were 2.72% high, and 1.67% below those of a weir; that is, there was a greater discrepancy between the current-meter and weir determinations than between the venturi and either of the others.

There are now important installations of venturi irrigation meters on the Salt River, Sunnyside and Yuma projects of the United States Reclamation Service; in the Imperial Valley by the California Development Co. at Calexico and by the Imperial Water Co. at Imperial; and by the Termescal Water Co. at Corona, Calif.

Traveling Tower Cantilever Crane for Yard Service

An unusual yard crane has recently been put into service by the Cleveland Railways Co. in its new Harvard St. yard. The chief purpose of the machine is to handle sand, coal, broken stone, etc., from and to storage piles. It is a tower crane traveling on a straight track and equipped with a long cantilever jib carrying a traversing hoist from which a grab bucket is suspended.

The general outline drawing herewith shows the structure of the crane quite clearly and gives also the principal dimensions. The tower is carried by two 30-in. rolled-steel double-flanged wheels at each corner. The axle of one wheel of each pair is extended to take a bevel gear driven through shaft and gear connections by a motor just above the portal. The gear shaft nearest the motor carries a brake wheel, with brake shoes pressed against the wheel by springs and released by compressed air when the crane is to be moved.

The top of the tower carries a circular girder 18 ft. in diameter, on which are a rail and a rack circle. The cantilever is supported at four points on the rail by two 24-in. rolled-steel wheels. It is rotated by a pinion on a vertical shaft extending from the rack up to the motor in the machinery house directly above. A manually operated brake controls the rotation. The trolley, a steel frame supported by four 16-in. cast-steel wheels, is designed for handling a 2½-yd. grab bucket, maximum load about 15,000 lb. There are two 20x42-in. drums on the trolley, each driven by a geared motor; one drum handles the closing line and the other the two opening lines of the bucket. The two opening lines are attached to the bucket by an equalizer that holds them 24 in. apart. Equalizers at the ends of the trolley frame provide attachment for two pairs of ropes parallel to the track, leading to a motor-driven winding drum in the machinery house, by which the trolley is moved back and forth along the cantilever.

An operator's cab placed just under the cantilever track and in front of the tower contains all the controllers. This house is an inclosure of asbestos-covered corrugated steel on a steel frame. The floor is of wood. The machinery house, on top of the jib framework, containing the trolley travel and the rotating machinery and an air pump, is a corrugated-iron inclosure on a steel frame with a steel-plate floor. The crane-travel motor, over the portal, is protected by a hinged casing over the motor and brake mechanism. Similar casing is provided for the trolley hoist motors.

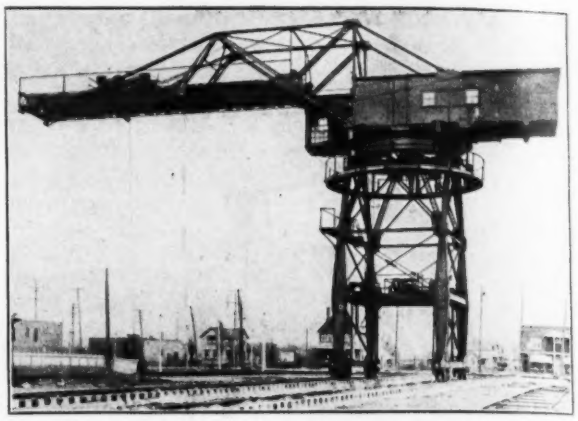


FIG. 2. TRAVELING TOWER CANTILEVER CRANE IN YARD OF CLEVELAND RAILWAYS CO.

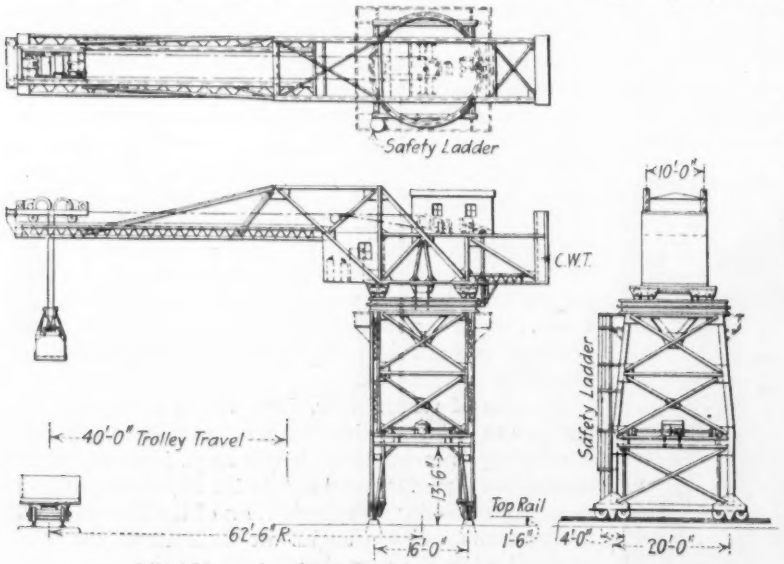


FIG. 1. TRAVELING CANTILEVER YARD CRANE, CLEVELAND RAILWAYS CO.

The speeds of the machine are 160 ft. per min. hoist speed at maximum load; trolley travel, 300 ft. per min.; crane travel, 100 to 125 ft. per min.; rotation, 2 r.p.m.

The crane was built by the Variety Iron and Steel Works Co. (Cleveland Railway Supply Co., Cleveland, Sales Agents). The bucket is of Lakewood Engineering Co. make, while the motors are Westinghouse Type K, 550 volts, direct current.

Engineers for Valuation—The valuation of public utilities has given employment to thousands during the past few years and there is no indication that the number of men required will be lessened for several years. This statement was made in a paper by G. L. Wilson, chief engineer of the Twin City Rapid Transit Lines, St. Paul and Minneapolis, read at the recent annual meeting of the Minnesota Surveyors and Engineers Society. The author showed that experience in cost keeping and knowledge of construction costs is necessary if this work is to be done properly. This field, requiring the services of many engineers, should not be neglected. Rather, engineers should post themselves in valuation methods and be prepared to do such work. The proper appraisal of property for purposes of taxation, for revenue charges and to determine values for investment, may be much more important than laying out and supervising the construction of new plants. Further, it may be noted that services of this kind are commanding higher returns than engineering service on projects of construction.

Turbine Pumping Station Below Ground in San Antonio

SYNOPSIS—Artesian-well pumping plant of the San Antonio Water Supply Co., which furnishes the supply of San Antonio, Tex. Greatest interest centers in a steam-turbine pumping station, the floor of which is about 47 ft. below original ground level.

The San Antonio water comes from artesian wells varying in depth from 800 to 1,000 ft. Under normal conditions these wells flow with a head of 12 to 15 ft., but in times of extreme dry weather the head has been reduced. In order that the company might control the supply, the pumps were placed as far below the surface as was practical.

The main pumping station is in the business section of the city, on the banks of the San Antonio River, and derives its supply from 11 wells 8 to 12 in. in diameter. The pumping equipment was installed several years ago and consists of two triple-expansion Allis-Chalmers high-duty pumping engines, one of 25,000,000 and the other of 30,000,000 gal. daily capacity. These maintain a pressure in the mains of from 75 to 90 lb. per sq.in. and pump into a direct system of distribution—without even a standpipe. The high- and low-service lines are connected—but through check valves, automatic valves, and electric valves operated from the high-service station so that the relative load on the stations can be adjusted.

To supplement this supply and furnish service to the high-pressure district of the city, a new pumping station has recently been completed in Brackenridge Park, near some other wells in an outlying section of the city (see Figs. 1 and 2). On account of the high elevation of the ground in this locality, it was necessary to adopt unusual methods in the design of this station so that the pumps could be in a controlling position relative to the hydro-static level of the wells. This was accomplished by excavating a bowl in the surface of the earth near the river and in this park, the embankment on the river side acting as a protection from floods in the river. The interior of the bowl was terraced. The bottom of the bowl is 2 ft. higher than the normal water level of the river so that generally the bowl drains into the river. At such times as it does not, the storm water is cared for by special pumps for that particular purpose. The main pumps were placed 35 ft. below the bottom of the bowl. The pumping equipment consists of two steam-turbine-driven centrifugal pump units, having a combined capacity of

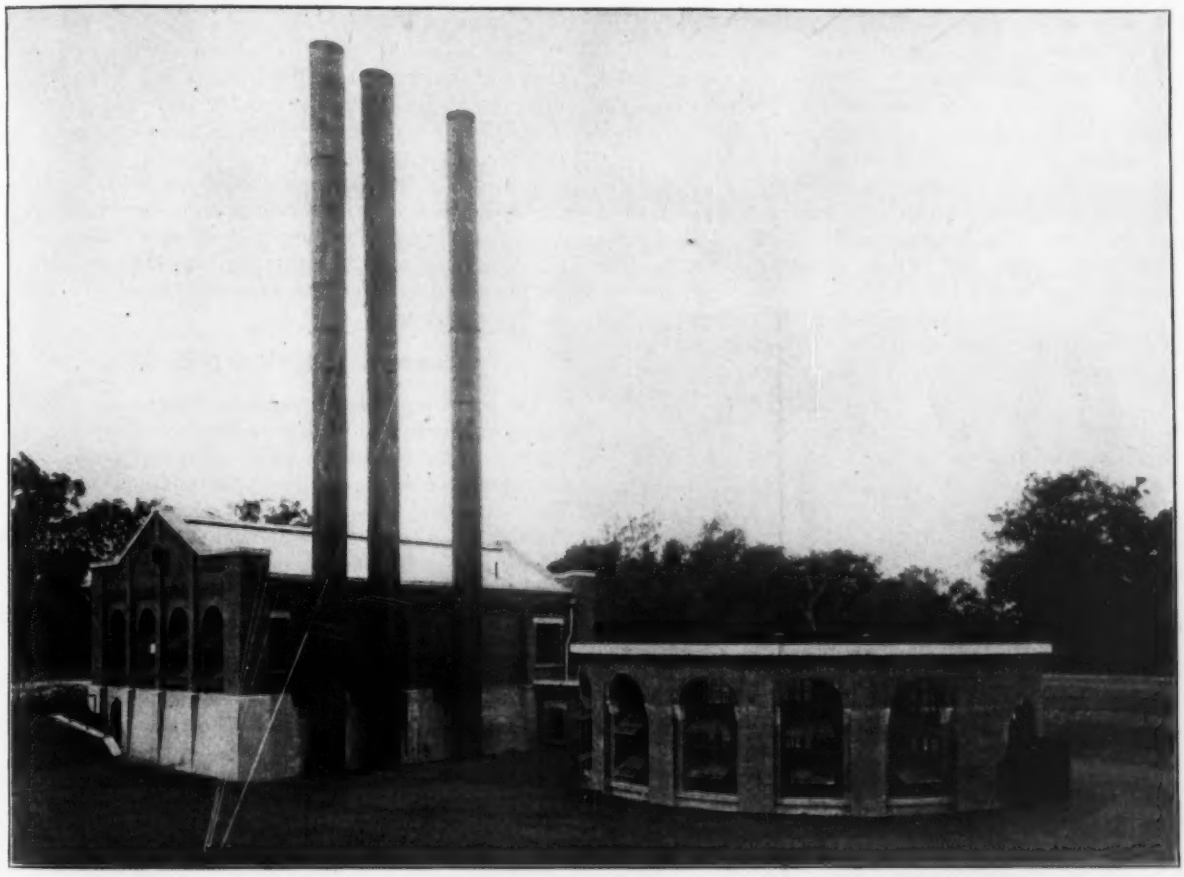


FIG. 1. VIEW OF BRACKENRIDGE PARK PUMPING STATION, SAN ANTONIO WATER-SUPPLY CO.

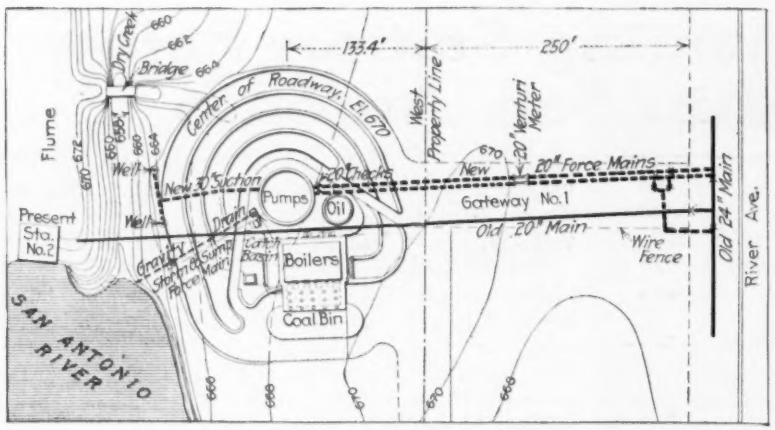


FIG. 2. GENERAL PLAN OF BRACKENRIDGE PARK PUMPING STATION, SAN ANTONIO WATER-SUPPLY CO.

26,000,000 gal. when pumping against 175 ft. head and of 13,000,000 gal. against 273 or 343 ft. head.

The pump chamber was constructed as an open caisson and was sunk in place by excavating the interior. The bottom of the cylinder is a cast-iron shoe with an outside diameter of 54 ft. 4 in., the inside diameter of the reinforced-concrete cylinder being 50 ft. (Fig. 3). The cylinder was built in three sections, each approximately 12 ft. high. The reinforcement consists of steel rods, steel bands, angles and fittings, as shown in Fig. 6. The concrete was mixed 1:2:4.

In the first cylindrical section of the concrete caisson a 40-in. hole was made and filled with a substantial water-tight wood form (see Fig. 7). When the cylinder reached its final position, this form was removed and the 30-in. suction pipe inserted in the tunnel prepared for it. The pipe was then concreted in the tunnel and around the opening in the caisson, so as to give a water-tight fit.

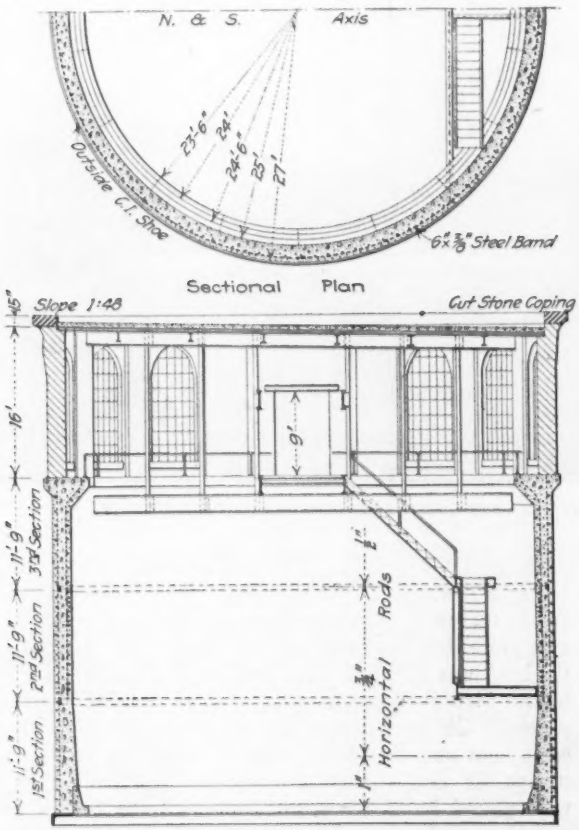
No exceptional difficulties were encountered in sinking the caisson. The upper strata of material were silt and gravel through which the cylinder slipped easily—in fact in some places a little too freely. Below this was a hard-pan, so tough as to break the tip off some of the iron shoe. Each section of the cylinder was tied to the one above by a 6-in. steel band, extending 3 in. into each section. Forms were made of wood strips of no greater width than 3 in. and were thoroughly braced so that the interior surface, as shown in Fig. 9, is almost perfect. Care was taken, of course, that the first section was not subjected to any stress before the concrete had thoroughly set. The steel I-beams for carrying the stairs and piping were cast in place in the cylinders as they were sunk.

The roof of the pumping plant is made of 4-in. reinforced concrete on steel I-beams. The lower 3½ in. is 1:2:4 concrete and the upper ½ in. is a 1:1½ mortar placed 30 min. after the lower course. On top of this is tar pitch and gravel. The expansion joints in the roof are filled with tar.

Boiler House, Coal Bins, Etc.

The boiler house is rectangular in plan, with concrete foundation walls and brick superstructure (Fig. 1). The concrete in the foundation walls was mixed 1:3:5; from the foundation to the brickwork the mixture was 1:2:4. The passageway from the boiler room into the pump chamber has 12-in. brick walls and steel beams, carrying a 4-in. reinforced-concrete slab roof covered with tar.

The boiler plant is arranged to be operated with either coal or oil fuel. The coal-bin roof is at ground level, so that the bins are entirely underground and invisible from the outside. The bins are shut off from the boiler room by fireproof rolling steel curtains or doors. The oil tank, which is not shown in Fig. 1, is between the smoke-stacks and the pumphouse. It is constructed of



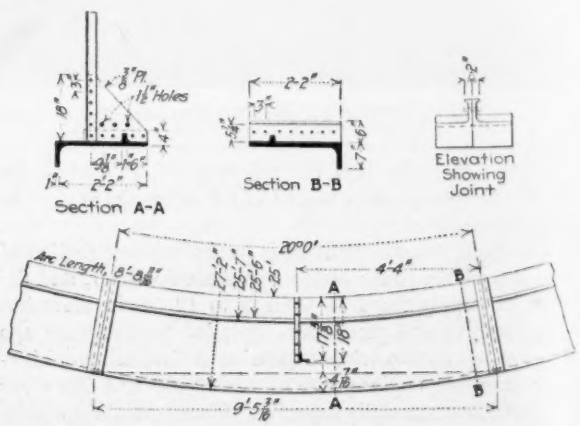
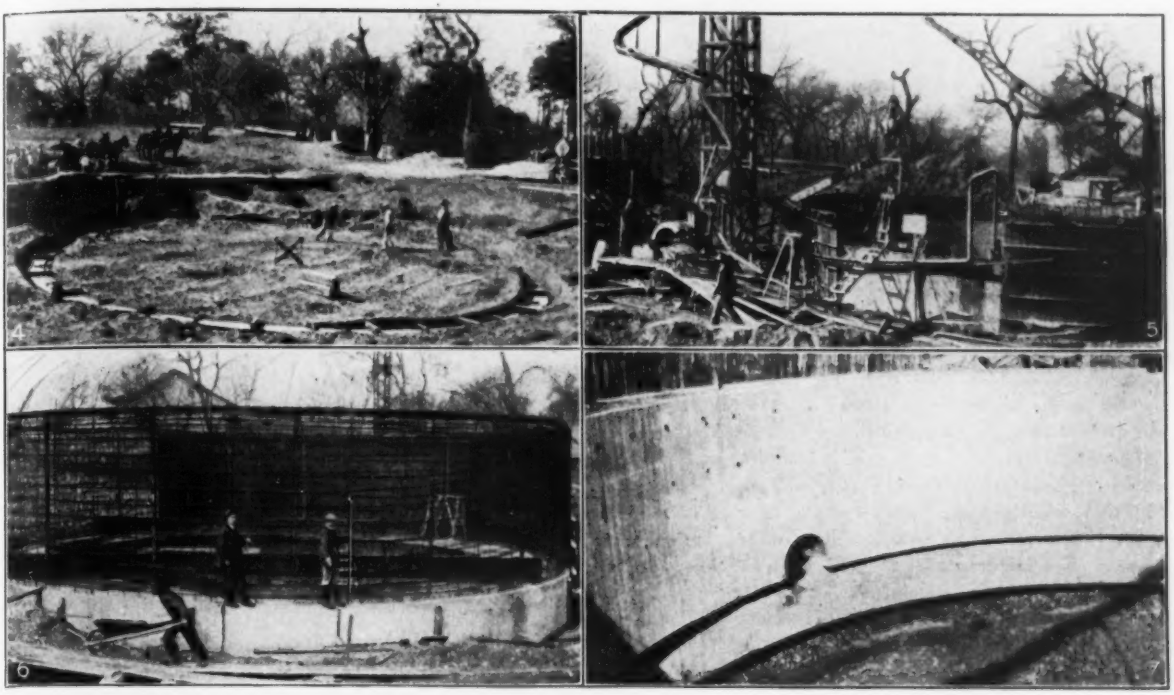


FIG. 3. CROSS-SECTION OF PUMP PIT AND HOUSE; DETAILS OF SHOE FOR CONCRETE CAISSON, BRACKENRIDGE PARK STATION

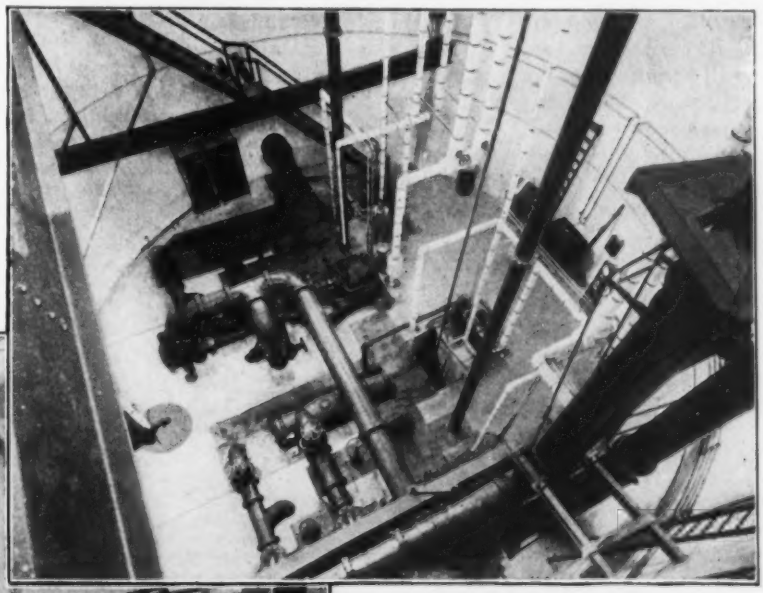


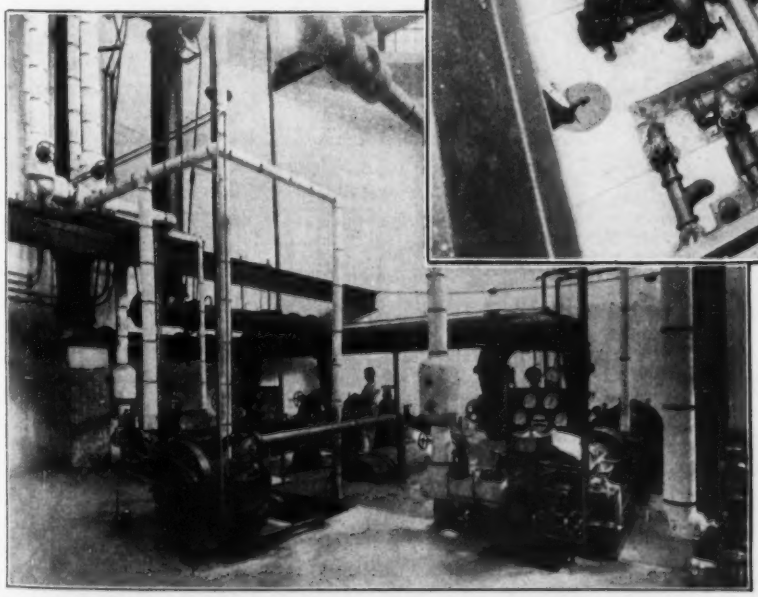
FIGS. 4 TO 7. VIEWS OF THE SINKING OF CONCRETE CAISSON PUMP PIT

4—Cast-iron shoe in position. 5—Placing concrete. 6—Reinforcement in position. 7—Bottom section of caisson, showing opening for suction pipe

reinforced concrete 1:2:4 mix. The roof is a 4-in. slab on I-beams, as in the case of the pump pit.

There are three 250-hp. water-tube boilers, each capable, without forcing, of evaporating 7,500 lb. of water per hr. at 150 lb. gage pressure. A working pressure of 170 lb. can be maintained if desired. Shaker grates for Texas lignite are installed; these are to be covered with firebrick during oil-burning periods and the burners set near the boiler front.





FIGS. 8 AND 9. INTERIOR VIEWS OF BRACKENRIDGE PARK PUMP PIT

The grounds surrounding the pumping plant comprise a public park recently donated to the city by the water-works company, and the plant has been designed with the object of doing away with all unsightly and objectionable features. The water-works company is maintaining a very liberal policy in the conduct of its business, and this pumping plant is intended to be one of the show places

of the park, being open to visitors at all hours. The pump pit, or caisson, is surrounded inside by a high gallery, from which a bird's-eye view, such as Fig. 9, can be had of the whole interior. Drives, flower beds, shade trees and other features are being added to make the plant as attractive as possible.

Pumping Equipment of Station

In the pumping station are two steam-turbine-driven centrifugal units each rated at 6,500,000 gal. normal daily capacity. The pumps are designed for use in parallel on 175-ft. head (each then having a daily rated capacity of 13,000,000 gal.) or in series against heads of 273 or 343 ft. The normal operating head is 273 ft., and the highest pressure is used only for fires. Water is delivered to the pumps with a head of 5 to 50 ft., but the pumps are capable of operating with suction lift up to the usual maximum. Each unit is complete with a water-works-type surface condenser (for minimum vacuum of 28.5 in.), reciprocating pump, moving condensate to feed-water heater, and a crank-and-fly-wheel dry-vacuum pump. The condensers have side water connections to minimize the necessary station depth. The guaranteed duties of the pump units were 112,000,000 ft.-lb. per 1,000 lb. steam (saturated, 150 lb. gage) for 175 ft. head, 107,000,000 for 273 ft. and 112,000,000 for 343 ft.

The station also has in irregular operation two small low-lift turbine-driven pumps. One, having a capacity of 200 gal. per min. against 65-ft. head, is for pumping seepage and circulating water from a station pump pit; the other, having a capacity of 2,000 gal. per min. against 25-ft. head, is for handling storm water. Each of these small turbines runs noncondensing. The entire pumping equipment, including the auxiliaries mentioned, cost about $29,000 in place. The cost of the installation including building and equipment of all kinds totaled about $138,000. In an equivalent triple-expansion unit the pump alone would cost at least $105,000.

The foregoing data were obtained from Robert J. Harding, Vice-President and General Manager of the San Antonio Water Supply Co., who was chief engineer for the design and construction of the plant described.

Reinforced-Concrete Stairway for Hillside Footway

By R. F. Odell*

There has recently been completed at Passaic, N. J., a reinforced-concrete street stairway providing access to the top of a steep hill in Harrison St. and replacing an old wooden structure that had fallen into a bad state of repair through neglect. The hill is very steep, with a slope of about 44%, and attains its full height of 65 ft. in a horizontal distance of 160 ft. Numerous near-by residences required the construction of a permanent footway up the slope.

Details of the structure are shown in Fig. 1. It consists of three-pedestal piers carrying platforms 9 ft. 6 in. wide and 5 ft. long, with offset steps spanning, as slabs, the adjoining platforms. The upper and lower landings are of solid concrete, 5 ft. in width, 10 ft. and 8 ft. in length respectively. A slope of ¼ in. per ft. was allowed in each platform to provide proper drainage.

The stairs are 5 ft. in width throughout, with 10¾-in. treads and 7-in. risers. They were constructed in five spans of 13 ft. 5¼ in., one span of 9 ft. 10¼ in. and one span 4 ft. 5¼ in. in length; the short bottom length was constructed solid to the subfoundation. As shown in Fig. 1, each span consists of a slab 5 ft. in width and 5.83 in. in thickness normal to the bottom, increasing to a thickness of 9.17 in., also normal to bottom, for a width of 7 in. on each side, these projections forming a shallow girder to obtain additional stiffness. In each span the reinforcing is uniform. The longitudinal sys-

*Bureau of Engineering, City of Passaic, N. J.

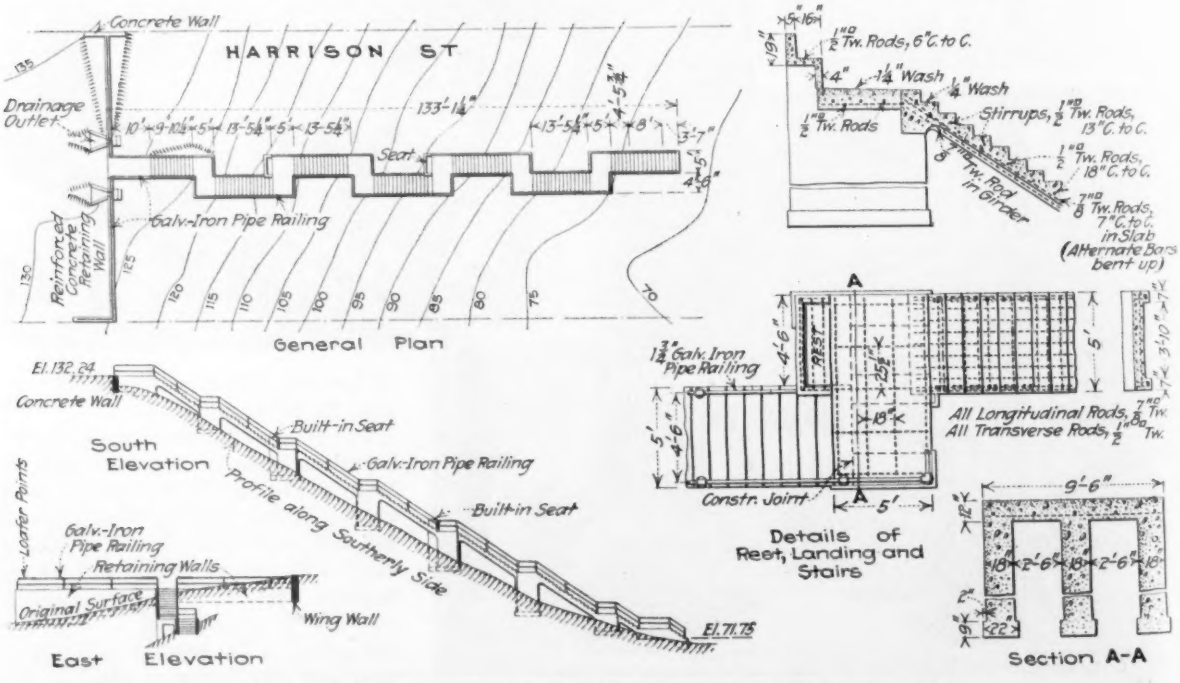


FIG. 1. DETAILS OF STAIRWAY BUILT BY CITY OF PASSAIC, N. J.

FIG. 2. CONCRETE STAIRWAY AT PASSAIC UNDER CONSTRUCTION

tem consists of ⅞-in. square twisted rods spaced 7 in. c. to c. with alternate rods bent up to provide for shear. One ⅞-in. rod was also placed in the bottom of each girder.

Stirrups of ½-in. square twisted rods were placed 13 in. c. to c. in the girders, as shown. Additional ½-in. square twisted rods were placed in the transverse direction, as shown in Fig. 1.

A rather novel feature was the placing of two ½-in. wrought-iron bolts, threaded ends up, in each end of each tread. By this means it is possible to bolt planks to the treads, if required in slippery weather. The treads were float-finished, however, and the use of the planks has been so far avoided. At a slight additional cost, patent nonslip treads could have been installed and would have been an ever present safeguard. The idea was abandoned by the designer because of the necessity of keeping within a small appropriation.

At the fourth and sixth landings concrete seats were constructed, as shown in Fig. 1, to afford rest from the long climb. This was a feature not included in the old structure, and it is much appreciated, especially during the summer months.

In order to afford adequate protection to traffic, concrete wing walls were constructed at the top of the structure. The portion north of the stairway is a plain concrete wall 1 ft. thick and about 3 ft. deep, serving as an anchorage for the guard rail. The conformation of the ground made it necessary to construct the portion south of the entrance of reinforced concrete, retaining an earth-fill 7 ft. in height at its extreme southerly end. Two outlets were provided throughout the wall, one on each side of the upper landing, to provide for a small amount of water draining easterly from the hill crest.

The whole structure, including the wing walls, is surmounted by a galvanized-iron pipe railing 2 in. in diameter. If this detail had been left to the discretion of the engineer, pipe of 3 in. nominal diameter would have been employed. As it is, the small pipe imparts a "spider web" appearance that is certainly out of place with the rest of the structure. The railing on the wing walls was provided with loafer points for its entire length.

Full data relating to the design of the stairway slabs could not be obtained. The writer has investigated the design with the aid of the usual beam formulas and has found $f_c = 800$ lb. per sq.in. and $f_s = 16{,}000$ lb. per sq.in. These values were obtained by assuming the dead-load at 115 lb. per sq.ft. and live-load at 50 lb. per sq.ft. normal to the slab; the combined vertical load totals 188 lb. per sq.ft. No allowance was made for snow or wind loads, the assumption being made that the live-load would be very small at times of heavy snow or high wind.

High elastic-limit steel was used, with concrete proportioned 1 : 2½ : 5. The foundations for the piers were excavated by ordinary day labor and were carried to varying depths, according to the nature of the soil. In several instances it was feasible to place the piers directly on good shale rock; but where no rock was available, no difficulty was encountered in finding suitable soil.

All piers and landings were completed and forms stripped before proceeding with the erection of the stair forms. Room was gained for the stair-slab seats by forming a jog in the landing slabs 1 ft. wide and 5 ft. long, extending down into the piers. The stair slabs were anchored to the piers by means of ½-in. square twisted rods, placed vertically. No direct provision was made for contraction, as it was assumed that the reinforcement would be sufficient for the purpose.

The concrete plant was located at the top of the hill and consisted of a ¼-yd. gasoline-driven mixer, to which the material was delivered by barrows. The concrete was deposited by means of a V-shaped wooden chute, which is shown in Fig. 2.

The entire structure, including the painting of the railing, was erected at a total cost of $1,851.45 and was completed in 50 days by the Gerritsen Construction Co., Lodi, N. J., under the direction of Colin R. Wise, City Engineer, who was also the designer.

The Unreliability of Shale as a Foundation Material for important structures is remarkably illustrated by the failure of a pier of the Penistone viaduct on the Lancashire & Yorkshire Ry. in England, which occurred on Feb. 2, 1916. A brief account of the accident was published in "Engineering News" of Mar. 9, p. 486. Additional information has now been furnished to us by Sir John Aspinall, general manager of the railway. The viaduct has 29 arches of 30-ft. span each, supported on piers of cut-stone masonry. The viaduct was built in 1849 and during its 67 years of service had never given the slightest indication of weakness at any point until about a fortnight before the accident, when a small crack was noticed in the masonry of the parapet over the pier that afterward failed. Examination of the pier and foundation revealed nothing wrong. The failure occurred very suddenly, only eight minutes after a fast express had passed over the viaduct and when a switching engine was moving slowly across. Excavation of the pier foundation since the accident shows that the footing courses of the pier rested on a greasy shale rock and that the whole pier, notwithstanding its lateral support at the top by the connection of the arches resting upon it to the other piers, slid on the shale foundation. The masonry of the pier and arches was of excellent quality. Excavation has now been carried through the shale to firm rock beneath, and the pier and arches are being rebuilt as they were originally.

Engineering Literature

Los Angeles Aqueduct Report

The plan adopted for distribution of the report on the Los Angeles Aqueduct construction, described in a letter from the president of the Los Angeles Department of Public Service in *Engineering News* of June 8, 1916, is worth the general attention of engineers who are responsible for the preparation and distribution of official reports on important engineering works.

Most public documents issued by states or cities are published for free distribution and are customarily sent to whoever requests them, until the edition is exhausted. When a report is to be issued on an important and monumental piece of engineering work, it is very desirable that it be made available to all engineers who would value it and preserve it. The taxpayers of the city, however, ought not to be asked to bear this expense as will be the case if the volume is sent free to all who apply. Furthermore, free distribution of an important document is sure to divert a large part of the edition to those who send for it from curiosity and who will not permanently preserve it, while on the other hand many engineering reference libraries will find themselves unable to secure it.

Under the plan adopted, the moderate price of $1.95 is placed on the report (less than the cost of manufacture and distribution). As only such an edition is to be printed as is subscribed for in advance, all who desire a copy of the report should lose no time in sending the price mentioned to the Board of Public Service, Los Angeles, Calif.

CORRESPONDENCE

Selling Price of Books

Sir—It is seldom that any attempt is made to have humorous items appear in engineering books, but on occasions amusing features are unintentionally included in some of them. An illustration of this is the habit acquired of late years by many book publishers of inserting in each book a printed slip stating, "This book is supplied to the trade on terms which do not admit of discount." After reading this warning, the interested seeker after information quite naturally examines the volume to find what the price is that cannot be discounted. This is where the publisher has the laugh on the inquisitive engineer, as the price is never given in the book.

The reverse view of this inconsistency is shown by many books in our trade literature which have a selling price printed on the title page, but which are seldom sold and are intended for complimentary distribution. As these are usually very useful and valuable books, the engineer who secures them free can feel that the joke is not at his expense.

Good technical books are worth the price usually charged for them, and it is difficult for the buyer to understand why the selling price is not printed on the title page of every book. This would serve as a record for the purchaser and would also be a convenience to anyone who might examine the book and find it of sufficient interest to be a desirable addition to his library.

O. W. CHILDS.

Washington, D. C., June 3, 1916.

An Early Surveyor-Poet

Sir—The accompanying verses on surveying and the notes which follow them I have taken from the genealogical history of the Blake family (with which I am connected) by Samuel Blake, member of the Dorchester Antiquarian and Historical Society:

LINES ON SURVEYING

By James Blake

Upon our Needle we depend,
In the thick woods our course to know;
Then after it the Chain extend,
For we must gain our distance so.

Over the hills, through brushy plains,
And tedious swamps, where is no track,
'Cross Rivers, brooks, we with much pains
Are forced to travel forth and back.

Briars and thorns our flesh do tear,
And stubborn brush our garments rend;
Our Instruments need much repair,
Labour and toil our Spirits spend.

Sometimes with heat we are oppressed,
Then flies and Serpents they annoy us;
Sometimes for cold we have no rest;
And sudden heat and Cold destroy us.

Our fare is mean, our hardships great,
Amidst all which our Charts must keep,
And work come right, our lines run strait,
All plotted be, before we sleep.

When weary steps have brought us home,
And chain and needle have respite,
Scale and dividers in use come,
And fit all for next morning light.

And though we're careful in the same,
As haste and obstacles will yield,
Yet, oftentimes perhaps will blame,
When rough—Wild woods are made a field.

Written May 3, 1730.

There are deposited in the library of the Dorchester Antiquarian and Historical Society many plans of land in Dorchester and the neighboring towns, also other documents, by James Blake, together with one of his dialing instruments, all of great interest to antiquaries.

He was a noted land surveyor and made an actual survey of the whole of the then extensive town of Dorchester. In 1726 the "Annals" say:

This year Majr. Robert Spur, Roger Billing, Capt. Oliver Wiswell, Capt. Thos. Tileston, & Capt. Saml Paul, Committee, & James Blake Junr. Surveyor, began in ye month of May to measure ye Cedar Swamps, &c. This year ye Proprietors, Incorporated into a distinct Body from ye Town, And ye Colony Line Run & Settled by ye Gen. Court.

James Blake was Proprietor's Clerk for the owners of extensive tracts of land in the town of Stoughton. In 1726 the "Annals" say:

> Punkapaog or ye South Precinct with ye Lands Beyond it in ye Township of Dorchester, were sett off a Township by themselves, by ye name of Stoughton, leaving Dorchester but a small Town, being narrow, and but abut 9 or 10 Miles in length.

I think the "Lines," which are perhaps the oldest verses on surveying written in the United States, will be of interest to the engineering profession.

CHARLES E. BEE,
Assoc. M. Am. Soc. C. E.
Gresham, Ore., May 13, 1916.

REVIEWS AND NOTES

Water-Conservation Problems

REVIEWED BY F. H. NEWELL*

CONSERVATION OF WATER BY STORAGE—By George Fillmore Swain, Gordon McKay Professor of Civil Engineering in Harvard University; Past President, American Society of Civil Engineers. [Addresses delivered in the Chester S. Lyman Lecture Series, 1914, before the Senior Class of the Sheffield Scientific School, Yale University.] New Haven, Conn.: Yale University Press. Cloth; 7x10 in.; pp. xvii + 384; 91 illustrations. $3 net.

During the present protracted and somewhat heated discussion of the water-power bills before Congress the book by Professor Swain on "Conservation of Water by Storage" has peculiar interest.

The most striking feature of the book is Professor Swain's somewhat full discussion of conservation in general and his criticism, sometimes direct and at other times implied, of the men who have been prominent in conservation activities. While not mentioning Gifford Pinchot and his associates by name, yet to anyone familiar with the subject it is apparent that Professor Swain is advocating the viewpoint which is radically different from that so ably presented by the National Conservation Association of which Mr. Pinchot is president.

The broad facts of conservation in general, and in particular of the storage of water, are given in an interesting way. Two divisions of the latter topic are treated in separate chapters: First, that of water power which is being developed or may be created at dams built or authorized by the Government on navigable streams; and second, the closely related, but fundamentally different, problem of water power on the public lands, situated in the Western States and still under the control of Congress.

All will agree with Professor Swain that there is urgent need of better and more explicit water laws and will join in his regrets that so much time has been wasted in enacting them. It is to be hoped that this full consideration will not only educate the public but will also arouse a larger appreciation of the necessity of exercising wisdom in the matter of new laws guarding our natural resources for the greatest good of the largest number. Professor Swain urges with reference to water power that "instead of restriction the greatest possible use should be encouraged. That use should not be wasteful; nor is it consistent with sound principles of public and individual economy to have it used for extravagant purposes. But *any use* is better than *no use at all.*" His desire to have the water put to immediate use may be interpreted by strict conservationists as a willingness to sacrifice the broad principles to secure an immediate gain. He says:

> To his mind, there is no evil which can arise in the future from the unrestricted private or corporate control which cannot be legally remedied if it should prove dangerous to the community, or which is as serious a loss of the multiple conservation which the development of water power affords. There are many, however, who emphatically dissent from this statement, and who think that no development at all is much better than a development without due regard to the rights of the public—that is to say, to what they conceive to be the rights of the public.

The author points out that the impression is erroneous that "water power can be developed at very little cost and with very little risk." Continuing, he says:

> The risks attending this investment are serious. . . . The history of water-power enterprises is not by any means a history of unbroken successful efforts. It is strewn with wrecks, and there is no industrial field in which sound engineering preliminary judgment, as well as careful construction and economical financing, would seem to be more necessary.

Farther on, it is stated that "the conservation movement in the past, particularly as regards water power, has been too much dominated by the idea of enforcing the arbitrary powers of the Federal and State governments." The author is convinced that the Federal Government has no legal right to impose any charge for water power at private water-power dams on navigable streams, but shows that the contrary opinion has been supported by ex-Presidents Roosevelt and Taft, by Henry L. Stimson when Secretary of War and by Walter L. Fisher when Secretary of the Interior. He asserts that "the conservation movement, originating in a wise demand for the economical use of our natural (not national) resources, has too much deteriorated into a demand that those resources be retained by national Government and not permitted to be developed by private capital, except under restricted burdens." He also dwells upon the fact that "it is very important to avoid the attitude of mind taken by so many in these days, which assumes that average business morality is less than average public morality." He adds: "Government bureaus and officials in a democracy may be guilty of just as flagrant abuse of justice as kings or individuals."

Passing from the discussion of the political aspect of water conservation, Professor Swain devotes considerable space to a similarly much debated question—namely, the relation between forests and stream flow. After presenting the results of various investigations he cautions the reader against "extreme views, in either direction, with regard to the effect of forests," for:

> In this, as in every other subject that engages the human mind, men tend to go to extremes. Thus we find some who maintain that forests exert no beneficial influence upon stream flow, and are even positively injurious; while on the other hand some seem to believe that the preservation and extension of forests would absolutely regulate the flow of streams and would do away with floods entirely. Either view is manifestly wrong. The truth lies somewhere between.

The book closes with a chapter on floods. The appendix quotes various reports, presidential vetoes and other documents relating to attempted water-power legislation. There is also an excellent list of references.

The book as a whole is of interest not only to engineers, but also to citizens in general. While many will dissent from the conclusions on nonengineering topics,

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yet all will agree on the value of the presentation and of the convenient access afforded to the literature on this important subject.

For Engineers and Architects

REVIEWED BY CLYDE T. MORRIS*

THE STRENGTH OF MATERIALS: A Textbook for Engineers and Architects—By Ewart S. Andrews, Lecturer in the Engineering Department of the Goldsmiths' College, New Cross, and at the Westminster Technical Institute. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. x + 604; 264 illustrations. $4 net.

The subtitle, "A Textbook for Engineers and Architects," has evidently been kept in mind throughout the preparation of this book. All the subjects treated are handled from an engineering viewpoint and their practical uses emphasized. The following statement from the preface shows the author's aim:

> Nearly all engineering formulas are only approximately correct; . . . We cannot condemn too strongly the blind application to a particular problem of formulas which were never intended to be so applied; the unfortunate distrust which practical engineers so often have to "theory" is to some extent brought about by the fact that the theories that they see employed are often inapplicable.

There are many references in the text to the practical aspects of design, and many numerical examples are worked out showing the practical application of the formulas and principles developed.

The more abstruse and less frequently used parts of the subject, such as are often omitted or put in appendices, are placed in the body of the text in their proper order, but they are "marked with an asterisk and may be omitted on the first reading." This makes the book more valuable as a reference text and still suitable for the usual undergraduate engineering course. The subject is presented in 20 chapters that cover the usual topics as well as a few less frequently met with.

Chapter I, "Strain, Stress and Elasticity," in addition to the usual relationships of simple stresses gives the principal stresses and the ellipse of stress, marked for omission on the first reading. Chapter II, "Behavior of Materials Under Test," is good, and Chapter III, "Repetition of Stresses," contains an exceptionally well-written discussion of working stresses and factors of safety. The methods given of caring for impact in live-load stresses do not include the American Railway Engineering Association formula and are generally more cumbersome and less accurate.

Chapter IV, "Riveted Joints and Thin Pipes," seems a rather odd combination. The part on riveting gives little attention to the theory of riveting, but mainly deals with various practical rules that are not in use in America.

Chapter V, "Bending Moments and Shears on Beams," is good. Chapter VI, "Geometrical Properties of Sections," gives the usual demonstrations for centroid, moment of inertia, radius of gyration and also graphical methods of finding the same which are very good.

Chapters VII, "Stresses in Beams," VIII, "Reinforced-Concrete Beams and Oblique Loading," and IX, "Deflection of Beams," give the usual treatment. The graphical method for deflections is well given, but the mathematical demonstration is not complete in that the author assumes $\frac{M}{EI} = \frac{1}{R} = \frac{d^2y}{dx^2}$, without showing the terms neglected.

*Professor of Structural Engineering, University of Ohio, Columbus, Ohio.

Chapter X, "Columns, Stanchions and Struts," does not agree with standard American practice and does not give the underlying theories upon which many of the formulas used are based, nor does it give any test data to show the accuracy of them. Euler's and Rankine's column formulas are recommended for practical use, and the straight-line formula is referred to as being "used principally in America and giving very good approximations for rough working." Euler's formula is recommended also for reinforced-concrete columns.

Chapter XI, "Torsion," again does not give the underlying theory as well as might be expected. Three different formulas are given for combined torsion and bending, but there is no demonstration of their theory.

Chapters XII, XIII and XIV, on "Springs and Testing of Materials," are fair. The description of extensometers might have included the Berry strain gage, which has been found invaluable in this kind of work. Chapters XV, "Fixed and Continuous Beams," and XVI, "Distribution of Shear in Beams," are good. Chapter XVII, on "Flat Plates and Slabs," is very good. The girderless floor is not considered. Chapter XVIII treats of pipes, and Chapter XIX of curved beams, in which is given a good treatment of the stresses in chain links. Arches and hooks are not considered. Chapter XX, on "Rotating Drums, Disks and Shafts," is very good.

At the end are given a set of problems for each chapter, tables of the properties of British standard sections and a table of logarithms and antilogarithms.

References in the text to other authors are usually made by name only, omitting reference to the publication in which the particular theory may be found. This fault could be easily corrected.

Folwell's Sewerage Revised

SEWERAGE: The Designing, Construction and Maintenance of Sewerage Systems—By A. Prescott Folwell, M. Am. Soc. C. E., Past-President, American Society of Municipal Improvements; Editor of "Municipal Journal and Engineer." Seventh edition, revised and enlarged. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. x + 540; 46 illustrations. $3 net.

In the present edition of his well-known book on "Sewerage" the author has confined his attempts at revision to the portion devoted to specifications, where he has substituted the specifications not long ago adopted by the American Society of Municipal Improvements, and to the section on sewage disposal. In the latter he has given chief attention to advances in screening, to changes in tank treatment, and he has added a couple of pages or so on activated sludge. Besides giving a descriptive tabulated list of about 900 sewage-treatment works and adding instructions for testing sewage effluent, the portion of the section on sewage treatment, devoted to what the author terms "more refined purification," has been reduced in length.

By the use of smaller type for the specifications than was used in the earlier edition the pagination of the volume and its contents up to that point, except for the new specifications, remain unchanged until page 400, where sewage treatment begins. The net changes under the heading "Sewage Treatment" increase the size of this section of the book as a whole by about 35 pages.

In the sixth edition, published in 1910, the principal changes, as compared with the preceding edition, appear to have been in the sections dealing with the use of

concrete and with sewage treatment. It would therefore appear that, except for matter on the increasing use of concrete, the new specifications and two successive revisions of the section on sewage treatment, the volume is not materially changed from the earlier edition of some 15 years ago. The author can hardly be blamed for not going into extensive changes in a one-volume work on sewerage and sewage disposal in view of the two volumes by Professor Ogden, published since the earlier editions of Folwell, and particularly since the appearance of the three-volume work entitled "American Sewerage Practice," by Metcalf and Eddy. It is hard and discouraging work at best to keep any engineering book up to date. Mr. Folwell is to be congratulated in finding the demand for his single-volume work continue until now 19,000 copies have been issued with the present printing of the seventh edition.

Weighed and Found Wanting

SCIENTIFIC MANAGEMENT AND LABOR — By Robert Franklin Hoxie, Associate Professor of Political Economy, University of Chicago; Special Investigator of Scientific Management for the United States Commission on Industrial Relations. New York: D. Appleton & Co. Cloth; 5x8 in.; pp. x + 302. $1.50 net.

Much has been heard of the opposition of organized labor and of laborers generally to scientific management. After a scientifically conducted study of the subject the author of this volume weighs the evidence gathered with much care and joins with his two "experts," one representing each side, in declaring that the scales tip against scientific management as now conducted in that it does not afford "any adequate protection" to the "standards of living" set by labor.

The general scheme of the investigation, which was made for the United States Commission on Industrial Relations, was as follows: Statements of the claims of the two sides were formulated by the author and submitted to representatives of each side, those representing scientific management being Mr. Taylor, Mr. Gantt and Mr. Emerson, for revision and approval. Shops for investigation were designated by the three exponents of scientific management already named. Robert G. Valentine, Industrial Counselor of Boston, was chosen to represent the "employing management" and John T. Frey, of Cincinnati, Editor of the *International Molder's Journal*, on behalf of labor. Some 35 shops and concerns were visited, and in addition about 150 men on both sides of the case were interviewed. An extended questionnaire was also used.

The main part of the body of the book consists of the author's "Critical Examination" of the testimony gathered from the various sources indicated. It is interesting to note that the author found much diversity as to the theory and still more as to the practice of scientific management. One gathers from his pages that in his opinion most of those who set themselves up as leaders in the field are hardly worthy of the title and that the greater number of the subordinates are incapable, even as regards service to the true interests of their employers, while for the most part they utterly lack in knowledge of the human side of the problems with which they are dealing. The weaknesses of the relations of labor to scientific management the author hardly seems to take so much trouble to present. He doubtless intends to be absolutely fair to both sides; but if he has a bias, it appears to be against scientific management and in favor of labor.

The larger part of the book is taken up with appendices stating the attitude of scientific management toward labor and the claims of labor against scientific management, together with the lengthy questionnaire used in the inquiry.

The body of the book can scarcely fail to appeal to anyone who has much interest in either side of the question at issue, and the various appendices will be almost equally interesting to those who have a special interest in the subject.

Least Squares Explained

REVIEWED BY CALEB MILLS SAVILLE*

THEORY OF ERRORS AND LEAST SQUARES: A Textbook for College Students and Researchers—By LeRoy D. Weld, Professor of Physics in Coe College. New York: Macmillan Company. Cloth; 5x7 in.; pp. xii + 190; 11 illustrations. $1.25 net.

The subject of least squares is often so severely abridged as to lessen greatly the use of a very valuable tool, but in the book under review Professor Weld has admirably avoided this tendency. The author's desire, as stated in his preface, to produce at the same time a textbook for undergraduates and a reference for research workers seems rather too ambitious of consummation. The book is, however, excellently adapted for undergraduate use and is of especial value to those who are dependent on self-help to acquire sufficient facility in applying the principles of least squares to ordinary problems.

The eight chapters into which the text is divided follow each other in logical sequence and treat of their subjects in a clear and concise manner. The text begins with an elementary discussion of "Measurement" and passes through the general subjects of "Errors," "Probabilities," "The Principle of Least Squares," "Adjustments of Observations," Empirical Formulas" and "Weighted Observations," concluding with a chapter on "Precision and Probable Error." An appendix is devoted to advanced mathematical discussion of the principles used in the body of the work. This arrangement is very attractive in that the working formulas appearing in the body of the text may be used intelligently without tiring or befogging the mind, as is often the case with abstruse mathematical gymnastics.

As a whole the text has much of the charm and easy-reading quality that sustain interest in the mathematical books of Prof. John Perry, and it may well find a very useful place in the work-a-day library of a busy engineer as well as be a most instructive guide to the undergraduate student.

Farm Drawing and Structures

AGRICULTURAL DRAWING AND THE DESIGN OF FARM STRUCTURES—By Thomas E. French, Professor of Engineering Drawing, and Frederick W. Ives, Assistant Professor of Agricultural Engineering, in the Ohio State University. New York: McGraw-Hill Book Co. Cloth; 8x11 in.; pp. viii + 130; 182 illustrations. $1.25 net.

Being designed "primarily for students in agriculture and agricultural engineering," this book first takes up the general subjects of drafting and of working drawings. A long chapter dealing with a great variety of farm structures follows. Next come maps and topographical

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drawing, pictorial drawing, a variety of construction data and a brief bibliography. The subjects selected are practical, many of them having been chosen from executed designs by the authors.

Theory of Dam Design

REVIEWED BY F. TEICHMAN*

DAMS AND WEIRS: An Analytical and Practical Treatise on Gravity Dams and Weirs, Arch and Buttress Dams, Submerged Weirs, and Barrages—By W. G. Bligh, M. Inst. C. E., Inspecting Engineer of Irrigation Works, Department of Interior, Canada. Chicago: American Technical Society. Cloth; 6x9 in.; pp. 206; 122 illustrations. $1.50.

The author thus summarizes his own idea of the advantages of the method he has pursued in presenting the theory of dam design:

> For purposes of instruction in the principles of design no medium is so good as the exhibition of plans of actual works combined with a critical view of their excellencies or defects. The former is obtainable from record plans in many technical works, but the latter is almost entirely wanting.

The book is largely made up of material from chapters II, III and VI of the author's previous work, "The Practical Design of Irrigation Structures," but this material has been revised and amplified and the treatment brought down to date by the inclusion of many designs representative of the most recent practice. In its present form it presents a distinctly valuable, though in parts elementary, work on the mathematical procedure involved in the design of the various classes of masonry dams.

The volume opens with a complete exposition of the various analytical and graphical processes by which a gravity-dam section may be analyzed, the lines of pressure drawn and the maximum pressures determined, including the complete working out of the design of a section of 270-ft. height with a limiting unit pressure of 18 tons. Several of the more notable gravity dams are then analyzed more or less completely, and brief comment is made on their distinctive features. A discussion of the effect of hydrostatic uplift, due to pervious foundation, follows, but the only remedy suggested is the use of a rear apron, either entirely artificial or in part of silt deposited from the reservoir. No mention is made of the method of foundation grouting under pressure, and there is but a passing reference to the possibility of hydrostatic pressure occurring within the masonry body of a dam. The use of a formula for relation of maximum and mean unit stress, in which it is "assumed that any tension at the heel can be cared for by the adhesion of the cementing material or of reinforcement anchored down," and the failure to state clearly that the primary reason for the middle-third requirement is to eliminate the possibility of tension occurring at the heel, while of no moment to the experienced designer, might mislead the uninformed student.

The theory of arched dams is covered by the submission of two formulas—one for average and one for maximum unit stress due to arch action—and the statement that "experience has conclusively proved that if the profile be designed on the supposition that the whole is an elastic arch, this conflict of stresses near the base can be neglected by the practical man." Various existing single- and multiple-arch dams are then analyzed, a design for a differential buttress arch weir is worked out, and several typical flat-deck buttress dams (Ambursen type) are analyzed and criticized.

The next section of the book is devoted to the discussion of submerged weirs founded on sand. These are treated along the lines of two papers on that subject by the author, which were published in *Engineering News* of Dec. 29, 1910, and Apr. 13, 1911, but the present discussion treats the subject at greater length and includes discussions of a large number of examples.

Scouring sluices, barrages and regulating gates are treated in the concluding portion of the work. Some mention should have been made here of the roller dam, as developed under patents by a German firm, of which there have been a number of examples installed both in the United States and in Europe. These roller dams combine the advantages of water-tightness, ease of operation and long unobstructed openings and are entitled to consideration where these requirements are to be met. If this section of the book could be expanded to include examples of actual installations of the different types of gates developed for use in river control in lock and dam work, and the various automatic spillway crest gates, it would form a chapter of considerable interest.

To the designing engineer who desires a compendium of the results of modern theory and practice in this branch of engineering this work should prove of considerable value. The analyses are detailed and complete, the illustrative designs are well selected, and the critical comments of the author not only lend interest and variety to the discussion, but, based as they are on an intimate and varied acquaintance with this class of construction in India and Egypt as well as in America, are illuminative and suggestive. The "inexperienced reader" should be warned, however, that there is something more to the design of a gravity dam, for example, than the drawing of a right-angled triangle with the hypothenuse on a 2:3 batter; and this something more is a matter not only of drawing the line of pressures as per detailed instructions and making correct numerical substitutions in stated formulas, but it demands a knowledge of the underlying principles of graphics and of the derivation of the formulas from the fundamentals. Anything short of that, however skillful detailing it may be, is not engineering design. It is of course entirely outside the scope of the present work to enter into this field, but the very fullness of the treatment of the methods of analysis may perhaps cause the fact to be overlooked that this knowledge of the fundamentals is essential.

Plumbing Drawn and Described

MODERN PLUMBING ILLUSTRATED: A Comprehensive and Thoroughly Practical Work on the Modern and Most Approved Methods of Plumbing Construction—By R. M. Starbuck, author of "Questions and Answers on the Practice and Theory of Sanitary Plumbings." Third edition, revised and enlarged. New York: Norman W. Henley Publishing Co. Cloth; 8x11 in.; pp. 407; fully illustrated by 58 detailed plates made expressly by the author for this work. $4.

Little change seems to have been made in this edition except in minor details. The general scheme of the book is to present one after another element or a combination of elements of plumbing on plates and to accompany each plate with brief text consisting of explanations, warnings and directions. Toward the end the text expands, and various phases of water-supply and

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sewage disposal are presented. The volume closes with "Suggestions for Estimating Plumbing Construction." The plates are clearly presented, but many of the drawings they show might have been reduced to occupy one-fourth the space and printed in the text, thus saving 13¼ pages per plate. The type and the margins are also unnecessarily large. If the book were reduced to something like half in bulk and nearly, if not quite that, in price, its convenience and field of usefulness would be increased.

Steam-Boiler Design

REVIEWED BY WILLIAM H. BOEHM*

THE DESIGN OF STEAM BOILERS AND PRESSURE VESSELS—By George B. Haven, Professor of Machine Design, and George W. Swett, Assistant Professor of Machine Design, Massachusetts Institute of Technology. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. vii + 416; 197 illustrations. $2.50 net.

The authors have produced a book on the design of steam boilers and other pressure vessels that is considerably in advance of earlier works on the subject. Their aim is to harmonize rational theory with conservative practice, and they believe that the problems encountered possess particular advantages to students as a basis for the proper study of machine design. Wherever it was possible to do so, the formulas and rules given were obtained by rational rather than by empirical methods.

In the opening chapter the authors state that there is in existence upward of 14,000,000 hp. of boilers used in manufacturing operations in the United States alone. Where a few years ago a 100-hp. boiler was considered a large unit and 125 lb. per sq.in. was considered a high pressure, today 500-hp. units carrying 250 lb. per sq.in. are commonly encountered. The authors are of the opinion that 200 hp. or 78 in. in diameter is about as large a unit as should be adopted if the horizontal tubular type is selected. When vertical boilers are used, 400-hp. units are often employed; and when water-tube boilers are chosen, units of 500 or 700 hp. are common.

Other topics considered in the first chapter are the proper combustion of fuel, the grates, furnace settings, and the materials used in boiler construction. Standard specifications for such materials are given. There is also a digest of the Massachusetts rules for the construction of boilers, which, together with other information, should prove of great value to the designer.

The second chapter presents valuable information on the method of determining the stresses in the various parts of the boiler. The next chapter contains a complete discussion of riveted joints, together with detailed information and numerous tables showing how to determine the net efficiency of the various joints encountered in practice.

The proper proportion of heating surface to grate surface, the proper size of tubes, etc., are discussed in the fourth chapter, which also contains interesting details of construction and valuable information on the staying of flat and curved surfaces. Boiler mountings are profusely illustrated and discussed at length.

Complete specifications, with calculations in detail, are given for horizontal tubular, Scotch marine, vertical and the locomotive type of boilers, there being a chapter for each type. The ninth chapter is devoted to the design of steel tanks.

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The work should not only prove to be a valuable textbook for engineering colleges, but should also be a helpful guide for draftsmen, boiler-shop foremen, inspectors and others interested in the proper design and construction of steam boilers and other pressure vessels. The authors are to be thanked by the entire engineering profession for giving us so much help in such concise form.

Two Books on Welding

AUTOGENOUS WELDING AND CUTTING — By Theodore Kautny. Translated by the Author and James F. Whiteford, M. Am. Soc. M. E. New York: McGraw-Hill Book Co. Cloth; 5x8 in.; pp. xiv + 157; 130 illustrations. $1 net.

OXYACETYLENE WELDING AND CUTTING: Electric, Forge and Thermit Welding, Together with Related Methods and Materials Used in Metal Working and the Oxygen Process for Removal of Carbon—By Harold P. Manly, Chief Engineer, American Bureau of Engineering. Chicago: Frederick J. Drake & Co. Cloth, leather, 4x7 in.; pp. 215; 56 illustrations. Cloth, $1; leather, $1.50.

The growing importance of high-temperature methods of welding and cutting metals is illustrated anew by the recent appearance of two books on the subject.

Mr. Whiteford has given an interesting arrangement of European practice in oxyacetylene welding and cutting of metals, which should interest Americans having such work to do. The sections on Continental apparatus will be of less importance to such readers.

After a brief description of the several autogenous welding flames available, the text settles down to the oxyacetylene process, the one of greatest commercial development. Acetylene and oxygen generation precedes a few brief remarks on fittings and more extended descriptions of welding and cutting torches. The rest of the book (two-thirds) is devoted to welding technique—repairs of cast iron and steel pieces; fabrication of sheet-iron articles, boilers and miscellaneous vessels, small pipes and large conduits; special work on copper, aluminum, nickel, etc.

Mr. Manly's book is another addition of the publishers to a long list of works written for the mechanic, but of such merit and service as to be worthy of a place in the library of many technically trained men. The most of the space is devoted to oxyacetylene apparatus and work, though hand and electric welding and soldering are not perfunctorily passed over. The sections on brazing and thermit welding are too abbreviated to serve for more than casual reference.

The book opens with a short discussion of the methods of producing common metals and alloys, their physical properties and working into commercial shapes. The generation and storage of oxygen and acetylene gases are described at length. Prior to taking up technique of oxyacetylene work, common valves and torches are described. The welding practice as outlined covers advance preparation of the work, torch manipulation, gas regulation, etc.

Pan-American Road Congress

PROCEEDINGS OF THE PAN-AMERICAN ROAD CONGRESS, Held at Oakland, Calif., Sept. 13-17, 1915—New York City (150 Nassau St.): Executive Committee, Pan-American Road Congress. Paper; 6x9 in.; pp. 416. $2.

This bulky volume contains the papers and discussions that were presented at the Road Congress held at Oakland, Calif., Sept. 13-17, 1915, under the joint auspices of the American Road Builders Association and the American Highway Association. Although the attendance at the congress was rather disappointing, the published

volume of "Proceedings" indicates that the meeting was successful in eliciting a large number of papers and extended discussion upon them. While a great deal of the matter in the volume is of only passing interest, highway engineers will probably find some of the papers useful.

Oil Fuel in the Industries

INDUSTRIAL USES OF FUEL OIL—By F. B. Dunn. San Francisco, Calif.: Technical Publishing Co. Cloth; 5x8 in.; pp. 235; 108 illustrations. $3.

Mr. Dunn has gathered in this little volume the most complete collection of descriptions and data of oil-burning equipment yet seen. There are a minimum of general statement and a maximum of specific details and figures. There is an occasional point where the text could have been improved (for instance, where it is stated inadvertently that the density of the air increases with increasing altitude), but all such shortcomings disappear in view of the merits of the work. The author has given great prominence to available commercial apparatus, but without evident partiality as far as he goes; the inclusion of much such matter is essential to a book of this sort, no matter how undesirable in a treatise of thermo-dynamics. The author might profitably have gone farther. The variety of sources for much of the author's matter has led to a lack of uniform style and attractiveness in the illustrations. That does not impair the real usefulness of the book, of course, but it gives it a certain typographical handicap in these days of more attention to the artistic appearance of technical publications.

The author starts out with some comparisons between oil and solid fuels and many data on the physical properties of various oils. Storage and pumping systems are briefly described and then boiler-furnace arrangements found suitable. Not much is said in this last part about burners, heaters, etc.; these are grouped in a following chapter. Kilns, and furnaces for clay, lime, cement and glass works are described as they have been run on oil. There is here much information on the technology of these industries, particularly as it affects oil burning; comparative data on operation are included. Metallurgical work (copper and iron smelting and steel making) are similarly included. There are chapters on oil-burning locomotives and steamers. Small apparatus for domestic household service is taken up with the same definiteness.

Our Great Irrigation Works

IRRIGATION AND SETTLEMENT IN AMERICA—By A. D. Lewis, Circle Engineer, Irrigation Department, Union of South Africa; late of the Public Works Department of Punjab, India. Pretoria, South Africa: Government Printing and Stationery Office. Cloth; 8x11 in.; pp. 258; illustrated. 10/6, post free.

How 17 of the leading irrigation works in the United States impressed an engineer from South Africa and what points regarding them he saw fit to record for the benefit of engineers and government authorities on another continent can scarcely fail to arouse the curiosity of anyone in the United States who is interested in irrigation. In addition, the volume before us has much intrinsic merit because it sets forth in concise and readable terms the leading features of a number of the irrigation projects of the United States Reclamation Service, several Carey Act projects, some California irrigation-district projects and the very interesting Imperial Valley scheme in Southern California.

Besides outlining the irrigation features of the various works, the author pays considerable attention to conditions affecting settlers on the projects, including accounts of some crop experiments. At the close of the volume a brief "summary of important points" is given. The illustrations include a number of sketches and line drawings, besides some handsome halftone engravings.

Throughout, the author shows keen appreciation of the salient engineering and other points of the works which he visited. His journey through this country was undertaken in 1913, but his account of the works visited was not published until last year. The volume is well worth adding to the irrigation section of any engineering library, both because of its concise descriptions of so many important irrigation works and also because it is as true in engineering and matters of governmental policy as in poetry that there are advantages in seeing ourselves as others see us.

Mill Construction

HEAVY-TIMBER MILL-CONSTRUCTION BUILDINGS—By C. E. Paul, Construction Engineer, Chicago. Chicago: Engineering Bureau, National Lumber Manufacturers Association. Paper; 6x9 in.; pp. 66; illustrated.

A broad and illuminating treatment of the mill-construction type of building is made available in this publication. The defining elements, arrangements of framing and best details of mill-constructed buildings are discussed and illustrated. There are a few tables at the end, but the value of the booklet lies mainly in the descriptive discussion of the several elements of the mill-construction type. The booklet covers this subject so well that it should be on the shelf of every engineer concerned with building construction.

The Shingle Roof Dangerous

SHINGLE ROOFS AS CONFLAGRATION SPREADERS: An Appeal to the Civil Authorities and Civic and Commercial Bodies. New York City: National Board of Fire Underwriters. Paper; 6x9 in.; pp. 21; illustrated.

The argument put forward in this pamphlet of fire-insurance interests is essentially that the shingle roof is the worst element in producing conflagrations. Views and brief descriptions of the principal conflagrations of recent years support the argument strongly, although little stress is laid on the large proportion of nonshingled values destroyed in these great fires or on the fact that many conflagrations started and spread in nonshingled districts. In any event the substance of the booklet provides a forcible argument for considering fire-resistant roofing and should have the careful study of every architect, every intending home builder and all who have to do with city building laws and fire laws.

To record "municipal progress in Minnesota" the League of Minnesota Municipalities has recently begun publishing a bulletin once in two months, to which has been given the name "Minnesota Municipalities." G. A. Gesell is editor and Prof. Frederick H. Bass is associate editor (publication office, Engineering Building, University of Minnesota; 25c. a copy or $1.25 a year). The first two numbers contain articles on "Central-Station Heating in Minnesota," "Virginia's New Sewage-Disposal Plant," "Public Water-Supplies" and other subjects.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

AMERICAN WOOD-PRESERVERS' ASSOCIATION: Proceedings of Annual Meeting Held at Chicago, Jan. 18-20, 1916—Baltimore, Md. (Mt. Royal Station): F. J. Angier, Secy.-Treas. Paper; 6x9 in.; pp. 432; illustrated.

ARTESIAN WELLS AND METHODS OF PUMPING THEM—By John D. Kilpatrick, Consulting Engineer, 30 Church St., New York City. [Reprinted from the Journal of the American Water-Works Association, Vol. 2, No. 4, December, 1915.] Paper; 6x9 in.; pp. 18.

BULLETINS, UNITED STATES DEPARTMENT OF LABOR—Washington, D. C. Paper; 6x9 in.; pp. 57 and 26, illustrated.
No. 339, Experiments on the Economical Use of Irrigation Water in Idaho—By Don H. Bark, Irrigation Engineer. No. 348, Relation of Mineral Composition and Rock Structure to the Physical Properties of Road Materials—By E. C. E. Lord, Petrographer. 10c. a copy, from Superintendent of Documents, Washington, D. C.

CANADIAN DEPARTMENT OF RAILWAYS AND CANALS—Ottawa, Ontario, Canada. Paper; 7x10 in.; illustrated.
Annual Report for Fiscal Year from Apr. 1, 1914, to Mar. 31, 1915. Pp. 456.
Railway Statistics for the Year Ended June 30, 1915. Pp. 190.
Canal Statistics for the Season of Navigation, 1915. Pp. 108.
Telephone Statistics for the Year Ended June 30, 1915. Pp. 83.

CANADIAN DEPARTMENT OF THE INTERIOR, IRRIGATION BRANCH—Ottawa, Ontario, Canada. Paper; 7x10 in.; illustrated.
Reports on Irrigation, 1915. Pp. 23.
Report on Irrigation Surveys and Inspections, 1915. Pp. 72.

CONCRETE CONSTRUCTION FOR RURAL COMMUNITIES—By Roy A. Seaton, Assoc. M. Am. Soc. M. E., Professor of Applied Mechanics and Machinery Design and Superintendent of Construction, Kansas State Agricultural College. New York: McGraw-Hill Book Co. [Agricultural Engineering Series.] Cloth; 6x9 in.; pp. xi + 223; 96 illustrations. $2 net.

EARTH PRESSURE, RETAINING WALLS AND BINS—By William Cain, M. Am. Soc. C. E., Professor of Mathematics, University of North Carolina. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. x + 287; 99 illustrations. $2.50 net.

ENGINEERING BULLETINS, MICHIGAN STATE BOARD OF HEALTH—Lansing Mich. Paper; 6x9 in.; pp. 68 and 15; illustrated.
No. 7, The Investigation into the Causes of the Typhoid Fever Epidemic at Monroe, Mich., Occurring During the Summer of 1915—By James W. Follin. No. 8, The Sanitary Privy—By Edward D. Rich, State Sanitary Engineer.

ENGLISH AND AMERICAN TOOL BUILDERS—By Joseph Wickham Roe, Assistant Professor of Machine Design, Sheffield Scientific School, Yale University. New Haven, Conn.: Yale University Press. Cloth; 7x10 in.; pp. xv + 315; 57 illustrations. $3 net.

FIVE-FIGURE MATHEMATICAL TABLES, Consisting of Logs and Cologs of Numbers from 1 to 40,000; Illogs (Antilogs) of Numbers from 0.0000 to 0.9999; Lologs (Logs of Logs) of Numbers from 0.00100 to 1.000; Illologs (Antilologs) of Numbers from 6.0 to 0.5000, Together with an Explanatory Introduction and Numerous Examples; also, Trigonometrical Functions and Their Logs of Angles from 0° to 90° at Intervals of 1 Minute, with Subsidiary Tables—Compiled by E. Chappell, B.Sc., A. C. G. I., Assoc. M. Inst. C. E., Temporary Naval Instructor R. N., Late Lecturer in Engineering at the City and Guilds' (Engineering) College, Imperial College of Science and Technology, London, S. W. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. xvi + 320. $2 net.

GLIMPSES OF OUR NATIONAL PARKS—By Robert Sterling Yard. Washington, D. C.: Department of the Interior. Paper; 6x9 in.; pp. 48; illustrated.

IMPRESSIONS OF AN ENGINEER IN PUBLIC SERVICE—By Morris Llewellyn Cooke, Director of Public Works of City of Philadelphia. [Presented before the Engineers' Club of Philadelphia, Nov. 16, 1915.] Paper; 6x9 in.; pp. 15.

THE INDUSTRIAL ARTS INDEX: Subject Index to a Selected List of Engineering and Trade Periodicals for 1915—Edited by Marion E. Potter, Louise D. Teich and Helen M. Craig. Third Annual Cumulation. White Plains, N. Y.: The H. W. Wilson Co. Cloth; 7x10 in.; pp. 509.

MOSQUITO CONTROL IN PANAMA: The Eradication of Malaria and Yellow Fever in Cuba and Panama—By Joseph A. LePrince, C.E., A.M., Chief Sanitary Inspector, Isthmian Canal Commission, 1904-1914, and A. J. Orenstein, M.D., Assistant Chief Sanitary Inspector, Isthmian Canal Commission. With an Introduction by L. O. Howard, LL.D., Entomologist and Chief, Bureau of Entomology, United States Department of Agriculture. New York: G. P. Putnam's Sons. Cloth; 6x9 in.; pp. xvii + 335; 100 illustrations. $2.50 net.

A NEW PENETRATION NEEDLE FOR USE IN TESTING BITUMINOUS MATERIALS—By Charles S. Reeve, Chemist, and Fred P. Pritchard, Assistant Chemist, Office of Public Roads and Rural Engineering. Washington, D. C.: Department of Agriculture. [Reprint from "Journal of Agricultural Research," Mar. 13, 1916.] Paper; 7x10 in.; pp. 6; illustrated.

OPINIONS AND DECISIONS OF THE RAILROAD COMMISSION OF WISCONSIN (Madison, Wis.), Volume XVI, Feb. 10, 1915, to Nov. 15, 1915—Compiled by Lewis E. Gettle, Secretary. Cloth; 6x9 in.; pp. 936.

PUBLICATIONS, UNITED STATES BUREAU OF MINES—Washington, D. C. Paper; 6x9 in.; pp. 60 and 30; illustrated.
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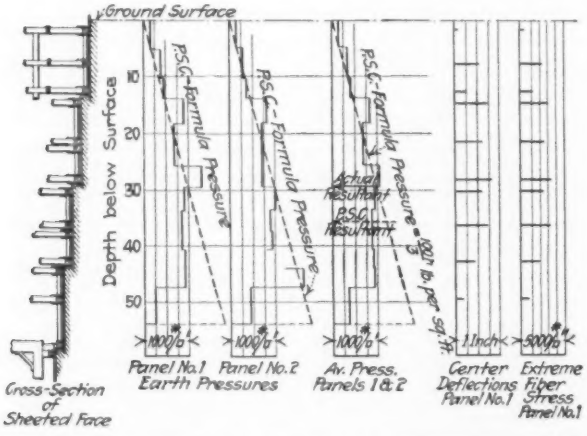
Field and Office

Tests Show Earth Pressures One-Half Hydrostatic

An excellent set of measurements of earth pressure against the sheeting of a deep trench was secured in the New York subway construction work recently. The tests were made at Prospect Park Plaza, Brooklyn, in a section being built by the Cranford Co. (John C. Sheridan, Chief Engineer), with maximum trench depth 80 ft. The trench side is held by wooden sheetpiling driven in five separate tiers. The pressure was measured by observing the deflections of the wales or rangers which lie along the sheeting and transmit its pressure to the transverse bracing struts.

The soil is glacial and consists of coarse sand with 20 to 30% clay, some gravel and occasional boulders.



EARTH PRESSURE AGAINST SUBWAY SHEETING; TESTS ON LENGTH OF 22 FT.

The fresh excavation face would stand as much as 12 ft. high and could be loosened and brought down only with the pick. Excavation was started 17 mo. before the observations were made, and in 11 mo. reached 60 ft. depth, later being carried down 20 ft. farther. Those connected with the tests consider that the earth had developed its full pressure when the observations were made.

The sheeting (3x10-in.) is 16 to 18 ft. long, with support by rangers (10x10 and 12x12) at ends and middle. The transverse braces are built-up 12x12's every 10 ft. longitudinally of the trench. Instead of trying to measure the deflection of a ranger on its full span, the observation was made on a shorter length, to eliminate local effects at the ends. On this fractional span a thread was stretched along the neutral axis, before the ranger was stressed, and later the offsets from this thread to five points on the inner face of the ranger were measured.

Specimen tests on the yellow pine composing the rangers showed the modulus of elasticity to average 1,500,000 lb. per sq.in. in bending. The modulus of rupture (of 1x1x15-in. specimens) ranged from 12,000 to 22,000 lb. per sq.in., which figures indicate that the actual extreme-fiber stresses of 2,000 to 3,000 lb. per sq.in. in the timbers are safe and justify the test method. By applying the modulus of elasticity to the observed deflections it was possible to compute the stresses in the timbers and hence their loads.

The results are given in the diagram reproduced herewith (from "Public Service Record," April, 1916, where Max Miller, Junior Engineer of the Public Service Commission, describes the tests and their results). The three broken-line diagrams in the middle show the pressures deduced for two adjoining panels of rangers and the average of the two. The maximum is around 1,000 lb. per sq.ft., which pressure prevailed from 25- to 47-ft. depth. Below 47 ft. a lower pressure was found.

Comparison with the Public Service Commission earth-pressure formula is afforded by the dash-line plot of the formula. The formula is

$$P = \frac{100h}{3}$$

which gives a trifle more than one-half hydrostatic pressure. The test results agree surprisingly well with the formula.

Mr. Miller points out that very many construction jobs afford opportunities for similar measurements. If such opportunities are utilized, much practical information on trench pressures can be accumulated in a short time.

Difficult Chimney Foundation Tested After Completion

A load test was recently made on a new chimney foundation of very original design in Pittsburgh. The test confirmed the engineers' judgment by showing that the foundation is amply safe under the intended loading.

In modernizing the boiler plant at the Brilliant pumping station, the city's Bureau of Water encountered a difficult problem in the design of foundations for two new steel chimneys 10x200 ft., since the soil is filled ground along the bank of the Allegheny River. Test borings showed that the subsoil fill consisted of well-compacted broken stone and shale mixed with red clay and a small quantity of gravel.

A test pit sunk to the level of the contemplated base of the foundation was loaded with a concentrated test load of 5,500 lb. per sq.ft. Immediately upon the complete application of this load a settlement of 0.028 ft. occurred in 20 min., at the end of which time movement ceased; the total settlement was 0.145. The soil at the elevation loaded consisted of well compacted soft shale, clay and small broken sandstone. It was concluded that a maximum load of 2½ tons per sq.ft. could be applied with safety.

Accordingly a mass-concrete spread footing unsupported by grillage was determined upon (Fig. 1). It is conical, with base area 730 sq.ft. and top area 346 sq.ft., the height being 13 ft. and the weight approximately 500 tons. The new stack comes directly over the

site of the old stack, which was built with an ashlar foundation supported on timber grillage. The old base was removed to a point 1 ft. below the level of the bottom of the new foundation block, and clay placed between the top of the old base and the bottom of the new,

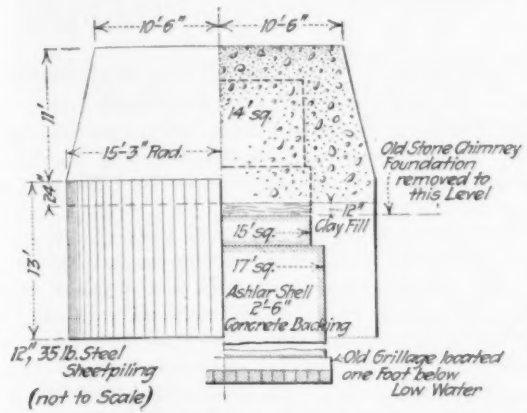


FIG. 1. SKETCH OF NEW STACK FOUNDATION AT BRILLIANT PUMPING STATION, PITTSBURGH

to prevent unequal distribution of the load over the bottom of the new block. As the elevation of the bottom of the foundation is below flood stage in the river a ring of steel sheetpiling was driven around the footing to a point 11 ft. below the base, to prevent scour due to fluctuation of water level.

The foundation block was poured as a monolith, without interruption of the work from start to finish.

The completed base was subjected to a loading of 1.6 tons per sq.ft. (including weight of base). This is about equal to the dead-load of the structure. A platform was built up, using four 15-in. I-beams 25 ft. long directly on the top of the foundation, crossing these with six 15-in. I-beams and three 12x14-in. timbers, and laying on this a floor about 25 ft. square. The materials used for loading consisted of 340 tons of dressed sandstone, available on the ground, and sufficient sacked gravel and cement to make the total load, together with 8 tons in grillage and platform, 680 tons, making a live-load of about 0.9 tons per sq.ft.

The load was applied uniformly over the entire platform. Levels were taken from time to time on the tops of four ¾-in. steel pins, one at each end of two 20-ft. diameters, 90° apart, whose elevation had been determined prior to the application of the load. They showed that an average settlement of 0.0055 ft. occurred during a lapse of five days, due to the weight of the completed foundation alone, which gave a pressure of 0.7 tons per sq.ft. By the time the test load was placed an average settlement of 0.028 ft. had occurred. An additional settlement of 0.004 ft. took place during the ensuing two days, making a total average settlement of 0.032 ft. under the full loading of 1.6 tons per sq.ft. Levels taken as the loading was removed showed no reaction.

The Brilliant station work is being done under the supervision of Charles A. Finley, Managing Engineer, Bureau of Water, and C. O. Daughaday, Division Superintendent, Mechanical Division.

Filling Trestles on an Electric Railway

The line of the Fort Dodge, Des Moines & Southern Ry., running north from Boone, Iowa, follows the valley of the Des Moines River, keeping high up on the slope and crossing numerous lateral ravines and gullies. In the original construction (as a steam railway) trestles were used over these ravines, but several of them have been filled since the line was converted to electric traction.

Pipe culverts provide the necessary drainage. In the smaller gullies, where clay pipe is used, a vertical riser pipe is placed at the upper end, so that mud and soil will settle around this and the comparatively clear water will flow into the culvert. The riser will be carried up as the gully fills.

Four trestles are now being filled at about four miles from Boone. These average 320 ft. in length and 75

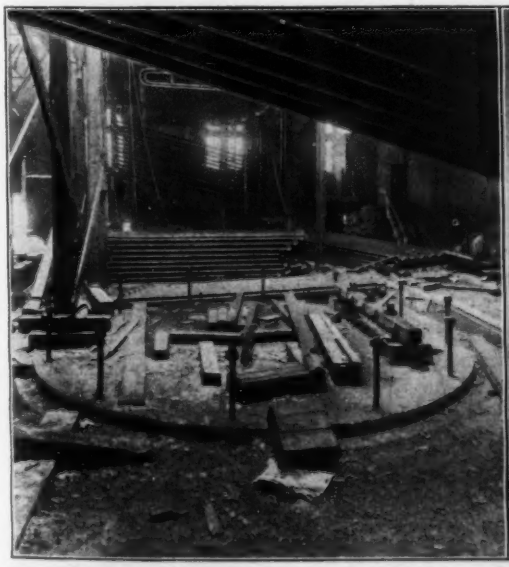


FIG. 2. ONE OF THE NEW CHIMNEY BASES AT BRILLIANT STATION

FIG. 3. TEST LOAD OF 680 TONS ON CHIMNEY BASE; ⅝-IN. SETTLEMENT

ft. in height, with about 52,000 cu.yd. in each case. The trestles are only about 800 ft. apart. This work is being done by Donald Jeffries, of Delmar, Iowa. The lower part of the fill is made with material from an adjacent cut. The contractor has a Bucyrus steam shovel, with 2½-yd. bucket, and two 11-car trains of 4-yd. Western dump-cars, with two dinkey locomotives. The cut being deep, holes are churned by hand near the edge and shots fired to throw the material down within reach of the shovel. The average load per car is about 3 yd.

An interesting arrangement of dumping tracks is used on the trestles. The deck has ties 12 ft. long, with guard rails inside the running rails. There was room, therefore, to place another line of rail near the edge of the ties, 3 ft. from the guard rail, so that the new outside rail and the guard rail formed the narrow-gage dumping track. Thus there are two 3-ft. dumping tracks gantleted with the main track, and these are so near the side of the trestle that the dumped material is thrown clear of the ties. This is shown in Fig. 1.

This arrangement of three gantleted tracks necessitated a rather complex crossing at the bridge approach, where the two dumping tracks were connected to the single

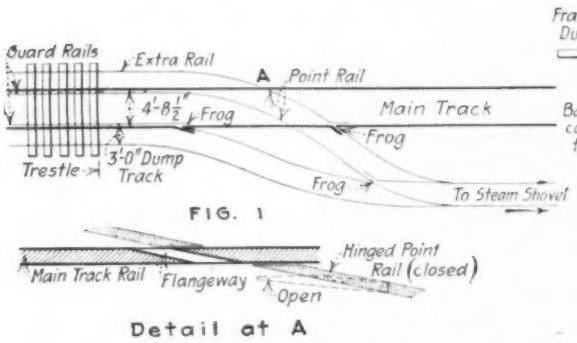


FIG. 1. ARRANGEMENT OF GANTLETED TRACKS FOR DUMPING FILL FROM TRESTLE

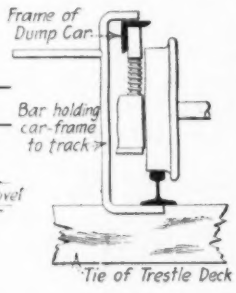


FIG. 2. BAR TO HOLD DUMP CAR ON TRACK WHEN DUMPING

3-ft. track (parallel with the main track) leading to the shovel pit, as shown. Frogs were put in the turnout, except where the rails of one of the 3-ft. tracks (60 lb. per yd.) intersected those of the main track (70 lb.). The latter rails were cut diagonally and separated far enough to give a flangeway. On the outer side the dump-track rail was cut at the proper angle and butted against the main rail. On the inner side the dump track had a short point rail whose tapered edge was in contact with the main rail. When the main track was cleared for trains, these tongue rails were shifted away from the main rail and spiked, so as to give the necessary flangeway.

The dumping is distributed on both sides and both ends of the trestle, so as to build up the fill uniformly and avoid undue strains upon the structure. For this purpose a foreman on the trestle directs the dumping. Cars with heavy boulders are dumped near the ends. The longitudinal braces between the batter posts are soon broken by the falling loads. No timber is removed, except the stringers and deck.

The dumping gang consists of four men. Two of these uncouple the side chains, tip and right the car body and refasten the chains. The other men have bent bars that hook under the rail and over the car frame, as shown in Fig. 2. With a sticky load, the dumping of the car body might cause the whole car to tip and go over the trestle, and the bars are used to prevent this.

The working time is about 1½ hr. between trains. A telephone operator at the pit is in touch with the regular operators at the adjacent stations, Boone and Fraser, each four miles distant.

The material in the cut is a soft loose clay, with some boulders. This is used only for the bottom half of the fill. For the upper part a more stable material will be used, obtained from a gravel pit about 1½ mi. distant. This is a mixture of gravel, black soil and blue clay and packs very solid.

The soft and loose material in the cuts previously mentioned causes trouble by sliding, and when wet it becomes a semi-liquid slush. In wet weather a considerable amount of ditching is necessary to keep the roadbed in condition. For this work an "American" ditcher is used—a small steam shovel which travels along the cars of the work train, excavating the slide and loading the material on the cars. In one slide last winter the wet mud covered the track so that the ditcher could not work. A snow-plow was then sent out and cleared the mud from the track so that the work train and ditcher could be operated.

In each of the fills now under contract is a culvert of reinforced-concrete pipe. The culverts range from 30 to 60 in. in diameter. The pipes are of the bell-and-spigot type, slightly oval (with the larger diameter vertical), and were made by the Massey Co., of Chicago. The pipes are laid in trenches cut to grade. The joints are not cemented; and as the bells are deep, the pipes can shift slightly with any settlement due to the load of the fill upon them. At each end of the culvert is a concrete apron to prevent scour, and a concrete headwall to retain the toe of the fill and to prevent any longitudinal movement of the pipe.

A concrete slab-deck subway will carry a road through one of these fills (near its end) to give access to the bottom land along the river.

Backfilling is placed by hand over that part of the culvert under the trestle, to protect it from damage by the material from the dump-cars. In one large culvert, built with comparatively green pipe, timber braces were placed inside while the fill was being dumped. The culverts have a grade of about 1 in 24, and the longest is 240 ft. between headwalls. The pipes are distributed along the roadbed by a work train. A derrick car, with locomotive, picks up a pipe, carries it out on the trestle and lowers it into place.

In some of the trestle filling done by company forces (at the Des Moines River bridge approaches) side-dump gondolas were used, the material being plowed off by a plow hauled by the motor car of the work train. With heavy loads or sticky material the motor was barely able to haul the plow. As these dump-cars stood on the main track (in the center of the trestle), the cars were equipped with aprons in order to throw the material

clear of the trestle. These aprons were of steel plate, bolted to the side sill. They had a slope of 45° and extended about 2½ ft. from the side of the car.

All the filling and ditching mentioned herewith are under the direction of L. E. Gagnon, Superintendent of Maintenance-of-Way. R. L. Cooper is Chief Engineer.

Ingenious Special Devices for Tunnel Surveys

Interesting special devices are employed in the survey work on two new tunnels now under construction in Milwaukee, Wis. One of them is a tunnel instrument table that is easily placed, easily taken down and that, when in use, does not block the operation of the muck-cars. In connection with it are points of novelty in the tunnel marks and the way of using them. These are features of the Shore tunnel of the new Linwood Ave. intake under Lake Michigan, north of the North Point pumping station. A similar system of marks is used in the Lake St. sewer tunnel in the northern part of the city. A new thing in this tunnel is a sighting fork for giving tunnel center-line grades from the roof marks.

Handy Instrument Table

The instrument table in the Shore tunnel serves as a support for either transit or level. The timber track floor laid inside the concrete lining of the tunnel is not steady enough to permit setting the instrument tripod on it, and an extension tripod set against the tunnel ring beyond the floor would block the haulage track. The portable table was designed by Lee G. Warren, resident engineer, to meet these conditions. It is wholly above car clearance and gives rigid support on the concrete lining.

The table, Fig. 1, consists of a 5x1¾-in. board transverse to the tunnel and somewhat shorter than its diameter, which is carried by and slides between two parallel ⅝-in. round steel bars 4½ in. apart and about 9 ft. long. Near one end each bar has a turnbuckle. By means of this the bars can be expanded or contracted to set them against the wall or release them. The ends of the bars are pointed, so that they can seat firmly in shallow pits or conical depressions chipped in the concrete wall of the tunnel. The bars extend along the sides of the table board and are held to it by metal straps and loops screwed to the board. The board is about 18 in. shorter than the bars, and near one end it has a long fine-thread brass adjusting screw engaging an abutment block in the board and a nut fastened to a crossbar fixed on the side bars. By this means the table board can be shifted transverse to the tunnel axis and the instrument centered accurately on the longitudinal axis of the tunnel.

Near the middle of the board is fastened a tripod head, which is used directly to carry the level. To mount

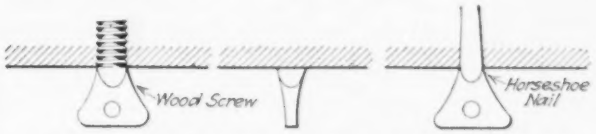


FIG. 2. NAIL OR SCREW ROOF-MARKS USED IN MILWAUKEE TUNNELS

the transit, a Berger cross-slide head is screwed on the fixed head. The screw-control slide adjustment of this special head enables the instrument to be moved parallel to the tunnel axis and thus makes it possible to center

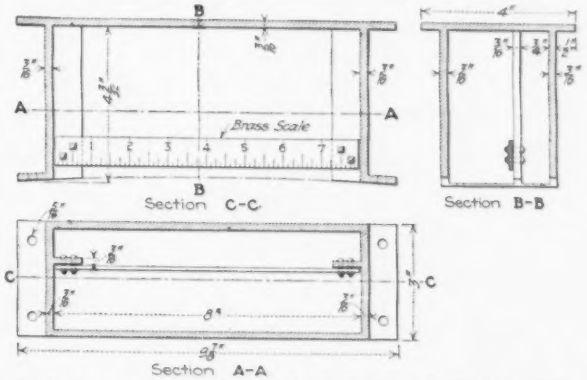


FIG. 3. SCALE ROOF-MARK USED IN LINWOOD AVE. TUNNEL

the telescope directly under the point of the plumb-bob suspended from the roof marks.

Before setting the table in place, two keel marks are made on the side of the tunnel at the proper point, and shallow depressions are then chipped in the concrete at the marks to furnish a secure seating for the ends of the bars. Then the table is lifted up, and the bars are expanded into the depressions. The instrument is at convenient height for observing, and the clearance under the table is sufficient for the ¾-yd. tunnel cars.

As the concrete lining in this tunnel is kept close up to the excavation face, survey marks are needed in the concrete only. About every 60 ft. a short block of 2x4 is concreted in the crown of the arch flush with the under

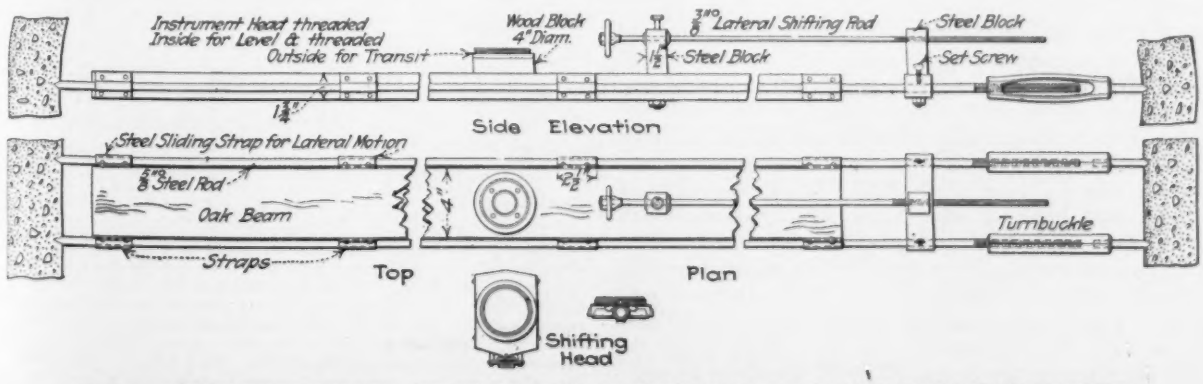


FIG. 1. QUICK-SHIFT TUNNEL INSTRUMENT TABLE USED IN LINWOOD AVE. TUNNEL, MILWAUKEE

surface, and later an alignment mark is screwed into the block. The mark is a woodscrew whose head has been forged flat and pierced with a $\frac{1}{16}$-in. hole, to serve as sighting point or to hold a plumb-bob cord. It is said to be not difficult to set these screws on center line (by transit sight) accurately enough for lining in the heading work and the forms. The two points nearest the face have plumb-bobs swung in them all the time until the next two points ahead have been set, and alignment of the headings and forms forward is obtained at any time by sighting past the cords.

For lining in to grade, similar screw points are set at springing line on both sides of the tunnel barrel. Strings stretched across the tunnel between the opposite points give the means of sighting forward and lining in the front of the concreting form to correct elevation.

Permanent Survey Marks with Scale and Vernier

Permanent roof marks for the accurate prolongation of the tunnel survey are set about every 125 ft. The mark is a cast-iron box concreted in the arch flush with its under surface, with a brass scale transverse to the tunnel axis fixed permanently in this box, as shown by Fig. 3. The scale is graduated to tenths of an inch, and it is read to one-hundredths by a portable vernier plumb-bob hook, not shown in the sketch. This vernier hook is carried by the engineer and is slipped over the scale for alignment sights, the vernier reading being recorded when the plumb-bob cord is on center line.

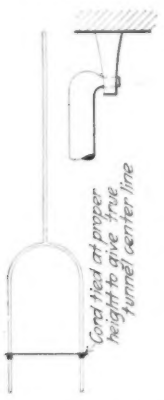


FIG. 4. GRADE-SIGHTING FORK

There is special need for accurate work in the alignment in this tunnel, because one of the shafts is driven about 30 ft. off the tunnel and reaches the tunnel by a crossdrift. Further, the tunnel makes an angle just at the point of entry of this drift; to insure correct running of the two headings from this shaft, therefore, rather accurate instrument work is required.

The permanent roof mark is also used for the definite reading of grades. Elevations are taken against the under side of the scale in the roof mark by means of an inverted level rod.

All headings of this tunnel are driven with compressed air. A roof mark is set in each air lock.

Roof-Mark System in Lake St. Sewer Tunnel

The Lake St. sewer tunnel, whose headings are worked under atmospheric pressure, has no permanent roof-mark system, but uses for both temporary and permanent service a roof mark like those employed by the inspectors in the Shore tunnel. There is a difference, however, in that the Shore tunnel roof marks are made of woodscrews with flat head, while R. H. Cahill, resident engineer of the Lake St. sewer tunnel, uses horseshoe nails with head similarly shaped and perforated.

These marks are set in pairs, 16 ft. apart along the tunnel, with an interval of 60 to 100 ft. between successive pairs. The pair nearest the heading excavation is used for sighting forward for the heading alignment and for aligning the forms. The theory of the arrangement is that it is fairly easy to sight along two strings that are only 16 ft. apart. On the other hand, it is not necessary to establish a new sighting pair every 16 ft., the interval of about 80 ft. being found very satisfactory.

For giving grade, side marks are not thought necessary, but the same roof marks are used by the help of a novel device, Fig. 4. It consists of a fork 3½ ft. long, made of light steel rod, with a hook-shaped lateral projection at the end of the straight or handle portion, this projection being about $\frac{1}{16}$ in. in diameter so as to fit into the perforation of the roof mark. When the fork hangs on the roof mark, a string stretched across the tines of the fork furnishes an excellent sighting point for grade. The string is adjusted for a given roof mark until it is just on tunnel center line, according to transit sight. The fork is then kept in just this adjustment (a record of the distance from hook to string is also noted) so long as grade sights need to be taken at this point. Hanging the proper forks at the two roof marks 16 ft. apart, a sight is taken forward over the two cords onto the front end of the concreting form until this is brought up to true tunnel grade. The headings are kept in grade and line by the foreman sighting by the marks.

Acknowledgments for information are due to the resident engineers, R. H. Cahill and Lee G. Warren, and to George F. Staal, City Engineer of Milwaukee, under whose general direction both pieces of work are being carried out.

Flange Makeup Diagrams for Heavy Plate Girders

Where heavy plate girders have to be designed, the labor of making up various trial flange sections can be eliminated by using the two diagrams shown on the opposite page. They give net areas of all cover-plate combinations (of 14-in. and 16-in. width) with 6x6-in. angles.

Ordinates represent total net sectional area; the several vertical lines are the successive thicknesses of angle. Each inclined line denotes a particular cover-plate section.

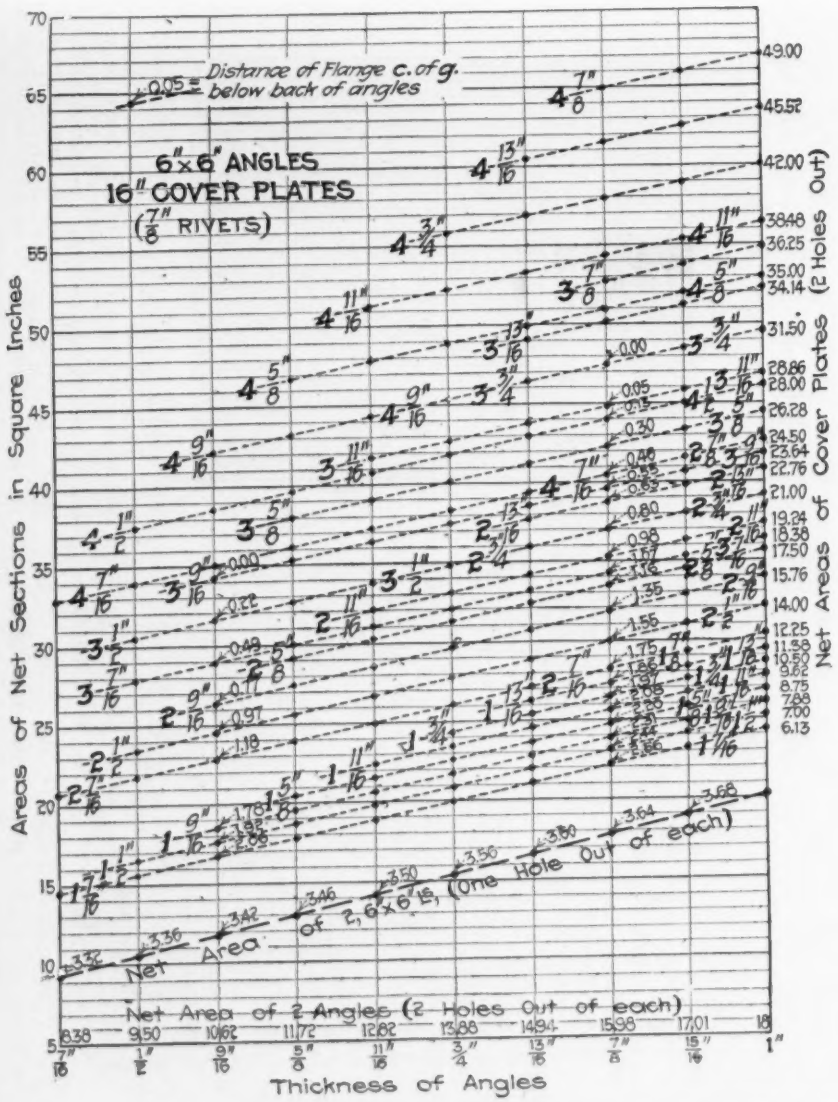
To compute effective depth of the girder, the distance from back of angle to center of gravity of flange is given for two of the angle sizes; intermediate values are easily interpolated.

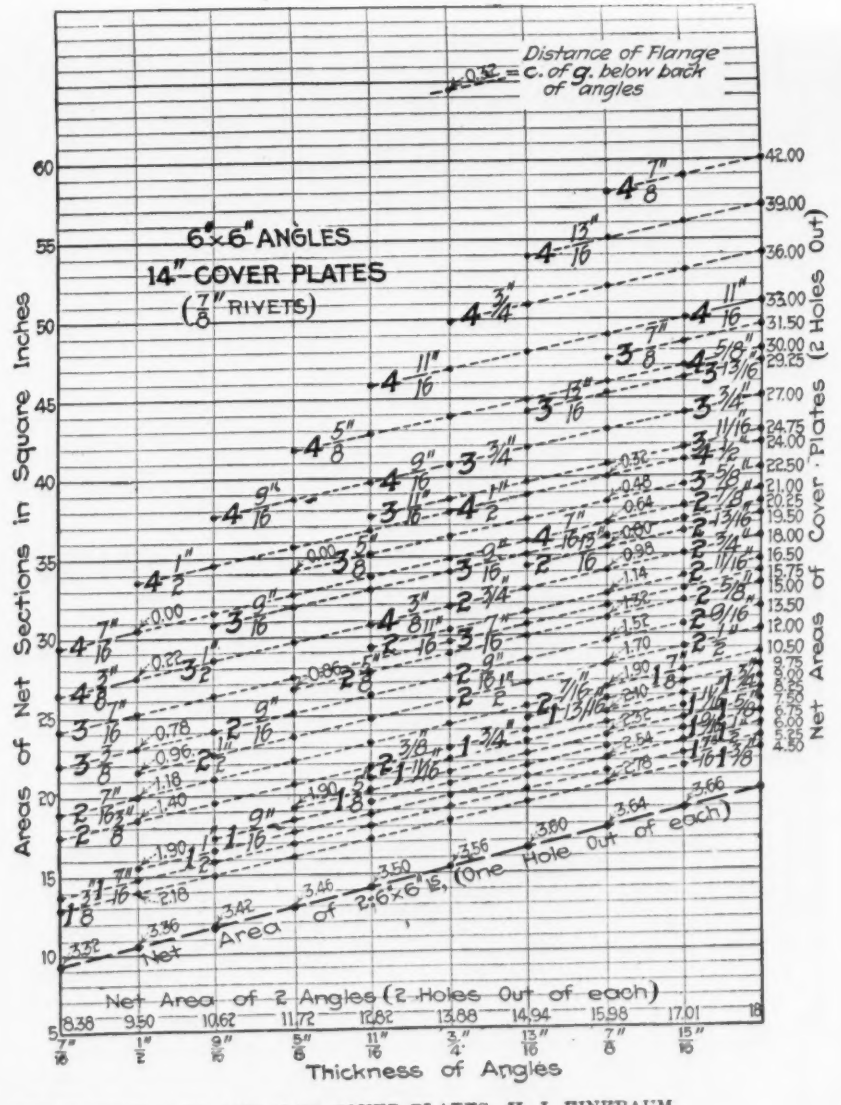
The cover plate area alone (with two holes out of each plate) is given by the column of figures at the right. The angle area with two holes out of each angle is given by a row of figures at the bottom; the area with one hole out of each angle may be read off the lowest sloping line, which represents a flange without cover plates.

Where a flange is to have a specified minimum percentage of angle area, the figures at the bottom should be used for net area, as the angles then have a hole in each leg.

The diagrams were devised by H. J. Finebaum, of the Engineering Department of the New York Municipal Railway Corporation. Similar diagrams for other sizes of angle or other plate widths can easily be made up by the reader. The two given are believed to cover the most common needs.

Flooded Basements Charged to Railway—On July 28, 1914, 4 in. of rain fell at Dickinson, N. D., in a 9-hr. period. The water backed up on the north side of a fill of the Northern Pacific Ry. The Supreme Court of North Dakota has just ruled that the railway was negligent, in failing to provide a culvert of sufficient dimension to carry away the flood. The damages were estimated at $50,000. The defense maintained that the cloudburst was an element they should not be compelled to take into consideration in building a culvert.


6"×6" ANGLES
16" COVER PLATES
(7/8" RIVETS)
Distance of Flange c. of g. below back of angles
Areas of Net Sections in Square Inches
Net Areas of Cover Plates (2 Holes Out)
Net Area of 2 Angles (2 Holes Out of each)
Net Area of 2, 6×6" ls, (One Hole Out of each)
Thickness of Angles

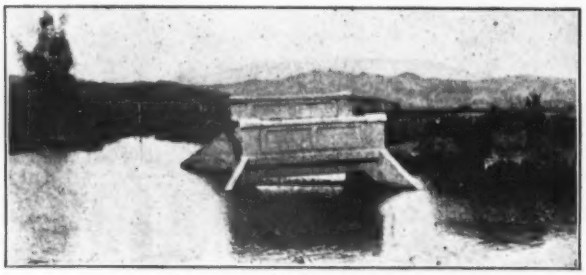

6"×6" ANGLES
14"-COVER PLATES
(7/8" RIVETS)
Distance of Flange c. of g. below back of angles
Areas of Net Sections in Square Inches
Net Areas of Cover Plates (2 Holes Out)
Net Area of 2 Angles (2 Holes Out of each)
Net Area of 2, 6×6" ls, (One Hole Out of each)
Thickness of Angles

FLANGE-MAKEUP DIAGRAMS FOR HEAVY PLATE-GIRDERS; 6x6-IN. ANGLES WITH 14-IN. AND 16-IN. COVER-PLATES—H. J. FINEBAUM

Total net sections, two holes out of each angle and each plate; 1-in. holes for ⅞-in. rivets

NOTES

An Undermined Culvert on the Albay-Camarines Interprovincial road, Philippine Islands, is shown in the view. This damage occurred in the latter part of 1915, when a large portion of southern Luzon was swept by a typhoon (Oct. 23, 1915). The concrete culvert of 4-m. span apears to be structurally intact in spite of the rough treatment it has undergone.



CONCRETE CULVERT UNDERMINED BUT INTACT

Cylinder Drops for Irrigation Ditches are being tried out on the Rio Grande project, United States Reclamation Service. They are of two types. One is shown in detail in Fig. 1. It consists of a grated concrete stop or baffle chamber, under which are a concrete box and a concrete flume outlet. The water entering the upper chamber falls into the box below through two circular openings in the floor. Over these openings are two steel cylinders that can be raised or lowered by a triplex hoist hung from a crossbeam over the cylinder. The cylinders are held in place by guides. The flow can be controlled with considerable precision by means of these drop gates. The second type of cylindrical drop gate being tried is similar to the first, except that the flow is up through the cylindrical gate (Fig. 2) instead of down, as in Fig. 1. This latter is known as the fountain type. The first type has been given use enough so that it may be called successful, although slight changes are made as new ones are installed. The second type, however, has not been thoroughly tried out. R. F. Walter is project manager of the Rio Grande project, and W. A. Perkins is designing engineer.

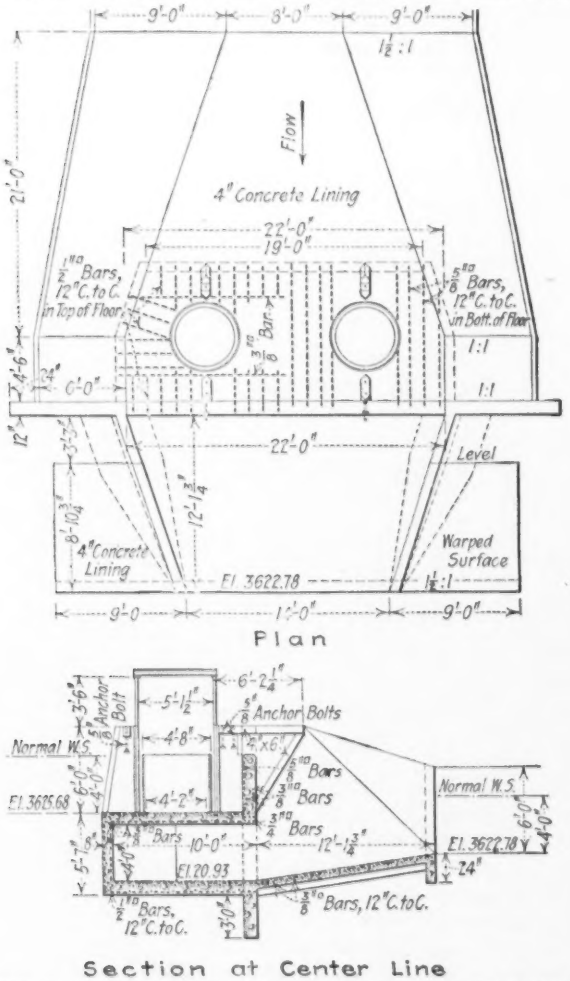


FIG. 1. CYLINDER DROP GATE BEING TRIED ON CANALS OF RIO GRANDE RECLAMATION PROJECT

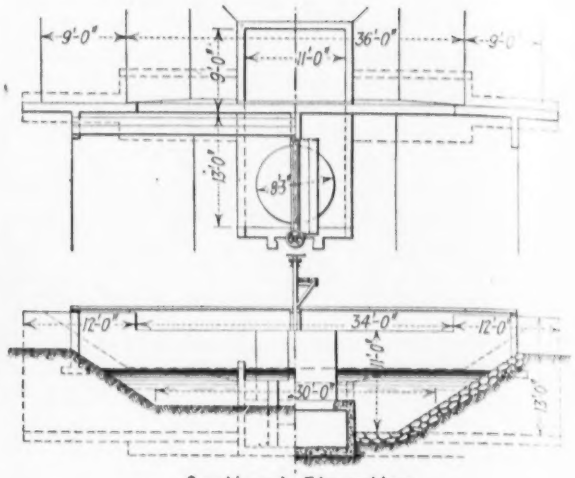
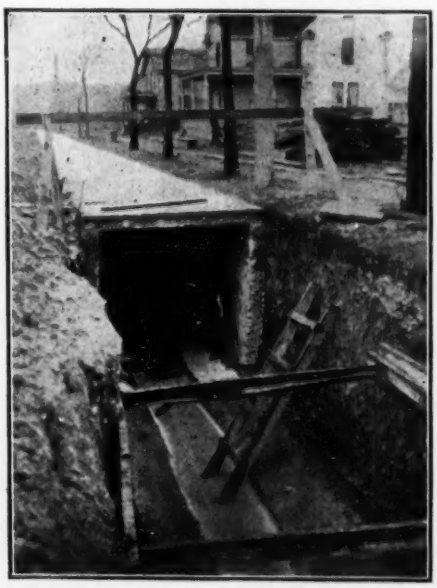


FIG. 2. CYLINDER DROP GATE OF THE FOUNTAIN TYPE

A Combined Sidewalk, Curb and Storm Sewer is now under construction at Ann Arbor, Mich., as shown by the accompanying view. The top slab, or sidewalk and sewer roof, is 6 in. thick and has 0.15 sq.in. of reinforcement per foot. The walls and invert are also 6 in. in thickness. The invert has sides on a 2 to 3 slope, joined by a curve of 1½-ft. radius. The interior width is 5 ft. The height of the vertical side walls averages about 5 ft. The invert is laid on a 3% grade. The grade of the sidewalk, however, and the drops at street crossings are taken care of by varying the heights of the walls. This sewer was designed in the office of Manley Osgood, City Engineer of Ann Arbor, and is being constructed under his direction.—Donald A. Thomas, 836 East University Ave., Ann Arbor, Mich.



SIDEWALK, CURB AND STORM SEWER IN ONE STRUCTURE, ANN ARBOR, MICH.

Editorials

Steady Progress of American Water-Works Association

The steady progress of the American Water-Works Association during the last few years is a fit subject for congratulation. Its membership has increased rapidly; for a yearly deficit it has substituted a handsome surplus; it has formed about a half-dozen geographical sections, with more in prospect, and has established a chemical and bacteriological section; it now publishes a good quarterly journal; and the exhibits of water-works appliances at the conventions have been increased in number and usefulness—thanks to the Water-Works Manufacturers' Association.

The indications of progress just named were notable facts a year ago, when *Engineering News*, directly after the Cincinnati convention, asked a question which has kept tongues and pens going more or less constantly ever since. That question was: "Can the American Water-Works Association Find Itself?"

At the convention held last week in New York City, President Hill devoted half of his able retiring address to the points raised in the *Engineering News* editorial and to some points raised by another technical journal a few weeks ago, which took the earlier article as its text. This portion of Mr. Hill's remarks is printed in full elsewhere in this issue. Although at one place in his speech Mr. Hill asserted in effect that he wished to make public denial of the "charges" that had been brought against the association, yet his address as a whole contained a number of statements and appeals that show that the American Water-Works Association has not yet found itself. We do not, however, wish to press this point. We recognize the force of the comment made by Mr. Hill that the American Water-Works Association is not the only organization of the kind that is trying to find itself.

Brief consideration may be given to some of the opportunities for further progress urged by Mr. Hill in the opening part of his address, not reprinted in this issue. First, there is the vast field for increase in membership. Mr. Hill pointed out that only some 500 water-works of the United States and Canada are represented in the association, whereas there are at least 6,000 such works in existence. Obviously, many of the 6,000 water-works are very small, but if only half of them were to be represented in the association and that by only one member each, there would be an addition of 2,500 members. There are many works that are now represented by several members and some that might well have, to put it modestly, from 5 to 25 members each.

It is pertinent to ask, Why should an association over 35 years old have less than 1,500 members today, when it has 6,000 water-works to draw from, to say nothing of the thousands of engineers, manufacturers and supplymen whose interests center largely in the water-works field? The most obvious answer is that either what the association has to offer to water-works men does not seem to them to be of sufficient interest and value to take at the price or else that the association fails in making the value of its membership known to the rank and file of the water-works men of the United States and Canada. We shall not attempt to say whether failure lies in either the one or the other or perchance in both of these directions.

Another need strongly urged by Mr. Hill was for an editor for the "Journal," in order to relieve the secretary from double service and enable him to give more time to the general work of the association, including membership campaigns. This suggestion certainly deserves most earnest consideration, but would not the present exigencies be met best by a single full-time secretary-editor? Heretofore, "permanent headquarters" in New York City or some other expensive center have seemed to be considered necessary to a full-time secretary—to say nothing of a full-time editor. A modest and inexpensive office, if need be in some relatively small city, might serve as "headquarters" for a few years. If it be urged that the finances of the association do not warrant even this expenditure, then it may be asked, What of the $4,000 gain in surplus funds reported for the past year?

A third line of progress suggested by President Hill was the provision of funds for committee work. An apparent falling off in the committee work was mentioned in these columns a year ago, and most of the committee reports at the New York convention last week were of the "progress" character. A lack of funds certainly had nothing to do with the failures of some committees to report and with the meager character of a number of the reports that were made.

Why, it seems fair to ask, should practically no appropriation whatever have been made for committee work heretofore and only $500 be recommended in the budget for the coming year, if the association is able to increase its surplus by $1,000 in a single year?

Other points might be discussed, but perhaps enough has been said to show that, while the American Water-Works Association has made steady progress in the past few years and is doubtless finding itself, there is still occasion for such searching examination of the aims and needs of the association as was presented by Mr. Hill in his notable address.

Carbon Steel Scores a Point

The "silicon steel" of the Metropolis bridge seems to show in its test performance such high qualities as have generally been credited to alloy steels alone. The table of tests and analyses from the regular acceptance routine for the bridge, printed in the last issue of *Engineering News*, indicates results that are quite as remarkable as the original announcement of a new material for the great structure.

Manganese and carbon can furnish strength more cheaply than a metal like nickel. If by the influence of a slight raise in silicon the steel can then be made

tractable, the inducement to use expensive alloys for high strength will be greatly lessened.

Departure from the standard 60,000-lb. bridge steel seems almost the regular thing nowadays. In the Hell Gate and in the Metropolis and Sciotoville truss bridges carbon steels of extra strength are employed. All three are squarely within the range of magnitude that in all recent discussions of alloy steels has been set apart as the particular field of these special materials. If carbon steel with the advantage of low cost can thus crowd alloy steels out of the bridge field before they have fairly entered it, new paths of development may be looked for in the art of building steel structures.

The Fruits of Parsimony

The Plattsburg dam failure, described in *Engineering News* last week, well illustrates the egotism of political wiseacres who rush in where an engineer dares not tread. The city fathers of Plattsburg, the same Plattsburg which has been so well advertised as the home of military preparedness, in their infinite wisdom abolished the office of city engineer, plugged the weep holes of a leaking dam built on glacial drift and, figuratively, thumbed their noses at any who had the temerity to suggest impending danger.

Astonishing as is such a performance, it can only be regarded as the crowning achievement of a parsimonious movement in city government (a reform and an economy the officials themselves probably would claim) which has been evident before in that city. The preceding administration nominally had a city engineer and a consulting engineer, but it overloaded the former by imposing on him the burden of design and inspection of this dam and it restricted the latter by accepting advice only as to the suitability of an earth dam on the site they had selected. These politicians refused to compare the disadvantages of the selected site and of others which might have been possible; they refused to consider the experience of contractors as dam builders and discarded the suggestion that a consulting engineer should check the design and supervise construction of the dam. Possibly they relied too much on the protection afforded by the apparently perfunctory approval of a State Conservation Commission restricted in its powers and limited in its appropriations. They did not even give the city engineer a resident inspector but persisted in requiring him personally to watch the construction while maintaining the street, bridge, sewer and water-works service of this active town of 12,000 inhabitants.

Passing to the technical aspects of the failure, it does not appear that the dam was poorly designed, once it is assumed that the site was imperative. The cut-off wall might readily have been deeper, particularly near the ends where the spacing of the steps makes the net depth at places less than the 20 ft. called for in the middle of the dam. A reinforced cut-off wall or at least a heavy reinforcement of the connection of wall to deck might have been included, but this would have been beyond the standard practice of the time or even of today. Finally, in view of the character of the ground some sort of paving or fore-apron would have been a desirable insurance.

In the construction one bad oversight seems to have been permitted. The trench sheeting for the cut-off wall was left in place if not for the whole length of the dam, at least for a large part of it, and the backfilling was anything but thorough. In consequence, there was perhaps a fairly open path for the water to traverse down and up the sides of the cut-off wall; if so the primary object of such a wall was lost. Even in placing the later puddled trench alongside of the wall the error was not rectified, for in places on the exposed wall the sheeting planks are now plainly visible.

Dams on porous foundations are ticklish things at best. In design, in construction and in maintenance, they require the most expert supervision. That such supervision was not present at Plattsburg is due to the non-technical city officials. This fiasco is depressing, of course, to all who hope to see intelligent municipal government spread, but doubtless it will teach a lesson, at least through the length and breadth of the Champlain valley, on the economics of spigot-saving and bung-hole wasting.

Traffic Capacity Limited by Unloading Facilities

That the traffic capacity of a great railway system may be limited by the unloading facilities of those who receive freight over its lines is clearly brought out in a circular just issued by President Howard Elliott, of the New Haven railroad. In connection with the efforts of that company to reduce the delays in freight shipments, President Elliott says:

> As a chain is no stronger than its weakest link, so is the capacity of a railway no greater than the capacity of its terminal facilities. This in turn is limited by the facilities of consignees and their ability to load and unload cars placed for them. Consequently the capacity of a railway to transport freight is measured by the rate at which cars are loaded and unloaded.

From the figures presented by President Elliott, it appears that for several months the capacity of the railroad to handle freight has been restricted by the slow unloading of freight by consignees. During the months of November and December last the average number of cars on the New Haven line in position for unloading each day was from 10,000 to 11,000. The average daily number of cars unloaded was 5,500. During March and April there was an increase in the average number of cars in position for unloading daily to 12,000 and 13,000, but the average daily rate of unloading fell to 4,200 to 4,300.

C. E. Clark, of the Interstate Commerce Commission, estimates that the traffic capacity of the New Haven system has decreased 50% by reason of slow unloading by consignees. President Elliott points out that the slow rate of unloading compared with the delivery of the cars has resulted in congestion on the unloading tracks and the connecting yards, making switching difficult. The congestion has also made it necessary to set out 2,000 to 4,000 cars at intermediate stations on the road, blocking the tracks there and delaying train movements. There were 1,000 to 3,000 cars similarly delayed at terminals, and from 10,000 to 15,000 cars delayed on connecting lines.

In examining the causes of the slow unloading it appears evident that one important cause is the congestion itself. When merchants or manufacturers know that there is likely to be delay in the shipment and re-

ceipt of goods, they order in advance of their requirements and often bring in goods faster than they are able to unload them. The start of the freight congestion appears to have been the very heavy orders for coal placed early in the year in anticipation of a possible coal strike.

It has long been understood by transportation experts that the capacity of a railway line is determined by its terminal facilities. The present experience of the New Haven company shows that a railway's capacity is dependent not only on the terminal facilities which the railway company itself controls, but on the freight-handling facilities of many hundreds or thousands of consignees along its lines.

Horse Cars To Disappear In New York City

For many years one of the curiosities shown visitors to New York City has been the few surviving lines of horse cars, which have continued in operation in the city where urban travel is far more dense than in any other city of the world, nearly a score of years after such vehicles disappeared almost everywhere else in the country. According to an announcement in the official publication of the New York Public Service Commission, the New York Railways Co. proposes to eliminate the last horse car from the streets of New York City this year. It is proposed that some appropriate celebration be made of the final abandonment of metropolitan horse-car transportation.

This antiquated device has persisted in New York City because of peculiar conditions which are not always understood beyond the metropolis. Overhead contact wires are taboo in Manhattan and the required underground conduit system is economical only for very dense traffic. About every form of self-propelled vehicle has been tried, including compressed-air and generations of storage-battery cars; the one exception seems to be the rail automobile in jitney form, though there was tried an experimental gasoline-engine electric motor street car which proved less economical than the modern light-weight storage-battery car with anti-friction journals. These cars have been used in increasing numbers here for three years.

High Plate-Girder Stresses

Though the plate-girder is popular, its claims of advantage are rarely given due recognition. When practical bridge problems lead to the use of such enormous plate-girder structures as the Worcester viaduct described in these pages last week, there does not appear to be much need of additional propaganda for the type. Yet the fact remains that plate-girders are never—or hardly ever—fully credited with their superior factor of safety over other bridge types.

If a list of badly over-stressed steel structures could be compiled, plate-girders would occupy a prominent place in the list. They withstand great amounts of unanalyzed abuse, and they rarely fail. The question is whether they should not receive a distinct preference in unit-stress on this account.

The very intricacy of the plate-girder from the structural point of view is responsible for its physical advantage over truss construction. Its parts hang together so intimately that most of the detail possibilities of failure existing in other steelwork are neutralized. Secondary stress, concentrations of stress not amenable to analysis, and local weakness due to composite character of cross-section or whatnot, have little or no meaning with respect to the plate-girder.

Truss design has constantly raised its permissible values for computed "direct" stress. Values are common today that greatly exceed the customary flange stresses for plate-girder construction. This condition ought to be reversed. A plate-girder structure of such arrangement of parts as to be secure against lateral yield, and protected against concealed rusting, should be allowed higher stresses than are permissible for any other form of riveted steelwork.

Comment was made in our issue of May 25 on a resolution of the Massachusetts Legislature directing the Public Service Commission of the state "to investigate the relations existing between railroads and railways in the commonwealth of Massachusetts." This resolution was decidedly mystifying to the average man who makes no distinction between these two words. A correspondent now informs us that the terms railroad and railway have been officially defined by a Massachusetts statute as follows:

> "Railroad" means a railroad or railway of the class usually operated by steam power.
>
> "Street railway" or "railway" means a railroad or railway, including poles, wires or other appliances and equipment connected therewith, of the class operated by motive power other than steam, and usually constructed in, under or above public ways and places.

It is certainly nice to have a legislature willing to supplement the work of the dictionary makers. Unfortunately, this brave attempt at precise definition leaves certain rail transportation lines in a "twilight zone." Suppose a line originally operated with steam locomotives is later changed to electric motive power. Does it thereby cease to be a "railroad" and become a "railway?" Is the New York, New Haven & Hartford a "railway" from New York City to New Haven, and a "railroad" the rest of the way to Boston? On some lines passenger trains have been hauled by electric traction, and freight trains by steam locomotives. Is such a line a railroad or a railway, under Massachusetts law? Again the law above quoted defines a "railroad" as "usually operated by steam power." But nearly all the electric railways in Massachusetts are operated by steam power. The electric current is merely a means of transmitting the power which is generated by steam in the central station to the wheels of the car or locomotive. What the framers of this Massachusetts statute really meant to say was that a railroad is a line usually operated by steam *locomotives*. It is painful to find such careless use of English under the shadow of the sacred codfish.

Each of the past three issues of *Engineering News* has contained an account of a dam failure. In each case the trouble lay with the foundation. This is not mere coincidence; it is the common history of dam failures. Amateurs in dam construction and maintenance who study and worry over the proper design of the section should note the fact.

Letters to the Editor

Sewer Pipe-Joint Question

Sir—The City of Durham is about to construct a standard 24-in. terra cotta sewer, through wooded, boggy land. This sewer line will carry sewage, dye waste and bleach liquor. A standard 10-in. terra cotta sewer will also be constructed through like country, carrying bleach liquor alone.

Our specifications have been drawn as follows:

In wet trenches and in quicksand and in such other places where directed by the engineer, the contractor shall furnish and use Jointite, GK or similar water-tight compounds. Where Jointite or GK compound is used the joint shall terminate at least ¼ in. back of the face of the bell, and a cement joint be made over it. The cement shall be protected by a bandage of cloth. The prices bid will be paid for such special joints. Where special joints are used three pipes may be joined together on the bank and laid at one time.

If the experience of your readers indicates that the cement collar on the outside of the joint is not needed, or throws any other light upon the proper joint to use under the conditions stated, I should be glad to have particulars given through your columns.

H. W. KUEFFNER,
Durham, N. C., June 3, 1916. City Engineer.

Claiming Over 100 Per Cent. Efficiency for a Pump

Sir—I notice in your issue of May 18, 1916, p. 950 an article entitled "Chain and Bucket Lift for Irrigation Water," describing the so-called "Famous Water Elevator," made in Denver, Colo. I quote as follows from the article: "In one plant now in operation, a 20-hp. gasoline engine in the altitude of Colorado raises 600 gal. per min. 135 ft."

If any of your readers will make the computation, they will find that 600 gal. per min. raised 135 ft. is the equivalent of 20⅓ hp. No gasoline engine will operate at more than its rated horsepower to say the least, at an altitude of 4,000 ft. (about the minimum altitude in Colorado) so that the published claim is equivalent to saying that the pump will operate at over 100% efficiency.

It is unnecessary to say to any engineer that neither this chain and bucket pump or any other pump ever made operates at 100% efficiency. Further, any engineer with any knowledge of machinery can see at a glance that any pump operating on this principle with its chain of dripping buckets, its numerous joints, its speed reduction gearing from the engine to the chain wheel, is bound to have considerable losses of power. He can see further that the wear and tear on the numerous joints exposed to water and grit, on the thin sheet iron buckets, and other parts will be pretty certain to make the cost of repairs and depreciation on such a pumping outfit very heavy.

Of course such an apparatus will operate and raise water, but what the irrigation farmer needs is a pumping outfit which will operate economically year in and year out and require the least adjustment and repairs. The irrigation farmer, however, generally knows little of mechanics and too often falls a victim to the shrewd salesman who claims that his particular pump will raise more water for a given expenditure of power than any other fellow's pump. When such claims creep into the columns of *Engineering News*, however, they should be promptly exposed and that is the object of this letter.

"IRRIGATION ENGINEER."
Salt Lake City, May 22, 1916.

Should Engineering Societies Pass on Public Questions?

Sir—The author of the article under this heading in Apr. 27, 1916, p. 818, of *Engineering News*, undoubtedly refers to the action taken by the Calgary branch of the Canadian Society of Civil Engineers in connection with the controversy over certain features of the construction of the large reinforced-concrete arch bridge now being built over the Bow River by this city.

The evident intent of the article is to create the impression that the society was not justified in taking the action which it did and that in so doing it was encroaching upon the rights of the consulting engineer.

The author passes over the facts of the case upon which the action of the society (of which he is a member) was based, with one or two statements which are misleading.

As the precedent established by the society in the attitude which it assumed is new, a concise statement of facts will be given in order that the profession may judge for themselves of the merits of the action.

For a period of nearly a year previous to the matter being taken up by the society there had appeared in the public press considerable adverse criticism of the engineering department of this city. This came principally from an alderman who had previously held the position of Water-Works Engineer for the city, but under a policy of economy his services had been dispensed with and the water-works department placed under the City Engineer. He thereupon entered politics and was elected an alderman. He also opened an office for the practice of consulting engineering; hence his statements and opinions regarding engineering matters received far more consideration from the public than otherwise would have been the case. The work of the city engineering department was greatly handicapped by this continual fault-finding.

Finally this criticism focused itself upon the construction of a large concrete arch bridge being built by the city over the Bow River at Centre St. and charges were made to the City Council by this alderman which reflected upon the ability and good judgment of those connected with the city engineering department.

The City Engineer was an Associate Member of the American Society of Civil Engineers and the local members of this organization, realizing the serious nature of this criticism, took the matter up with him, and after

hearing his side it was the unanimous opinion of those present that any further discussion of these matters in the daily press could serve no useful purpose and that the local engineering profession would lose prestige if it were allowed to continue.

Furthermore it was evident that if the facts were as he presented them, his reputation as an engineer was being attacked largely for political purposes. As this was a matter between engineers it was felt that it should be settled within the profession and that the local branch of the Canadian Society of Civil Engineers was the proper body to which to appeal. This would be quite fair as neither party to the controversy was connected with this organization and its membership was thoroughly representative of the local profession as well as containing some of the larger rate-payers of the city. At the same time the attention of the City Engineer was called to the fact that if the society could be prevailed upon to take the matter up, he must be prepared to abide by the findings of that body regardless of the consequences. With this understanding the whole matter was laid before the executive board of the local organization.

In the meantime the City Council had ordered the two Commissioners and Mayor to investigate the matter and report. The alderman had been prevailed upon to submit the verbal charges in writing and the City Engineer requested to answer them in the same manner.

In the interim between the submission of the charges and the answers, the executive board of the society unanimously decided to offer its services gratis to the board of commissioners to investigate and report on the matter. A set of resolutions embodying this offer were then drawn and adopted at a general meeting of the society. The city accepted the offer and requested the society to proceed.

Three members of the branch were then selected to act as a committee to make the investigation. The meetings were made public and held in the committee room of the council chamber at the City Hall and the proceedings were recorded by a stenographer furnished by the city. The alderman preferring the charges refused to appear before this committee for examination and they had no power to compel attendance. On the other hand the City Engineer, the engineer in charge of the design and construction of the bridge and the City Chemist, who had charge of the city testing laboratories, appeared and submitted very willingly to a thorough examination on the points at issue.

In brief the charges were as follows:

(a) The use of unsuitable rerolled steel in the structure and extravagance in the testing of same.

(b) Neglect or carelessness in not carrying the foundations of the north retaining wall to rock.

(c) Failure on the part of the engineering department to submit the design to a consulting engineer for endorsement, it having always been understood that such a course would be followed.

(d) The purchase of unsuitable cable for hoisting purposes during construction at a higher price than that at which suitable cable could be purchased.

The Commissioners assumed the responsibility for (d), thus relieving the committee from its consideration.

A few extracts from the findings of the committee will indicate how much foundation there was for these charges. These extracts are as follows:

As the impression conveyed by Ald.———'s charges is that the safety of the whole bridge has been jeopardized by the use of this rerolled steel the committee feel that this report is not complete without a statement as to what use was made or contemplated to be made of this steel. It has been used as reinforcement in the construction of the retaining wall which forms a part of the north abutment. It has also been used or is contemplated as dowels to furnish a bond between successive pourings of concrete in the river piers and springings. It was also used or contemplated in the curtain walls of the main piers and pylons of the river arches and as carrier or spacing rods in various other parts of the work. With the exception of the retaining walls, where its employment has already been covered by this report, the function of the steel is arbitrary and the material is subject to no definite stresses. In the pylons, the curtain walls are a mere architectural effect and have no structural functions. The steel is used merely to prevent unsightly cracks due to temperature and shrinkage stresses and its section is in most cases far in excess of possible requirements.

The statement has also been made by Ald. ——— that because the Centre St. bridge is larger than the Mission bridge, a better grade of material should be used. This is not correct. Mere size is no criterion, in fact the unit stresses in a large structure may be, and in this case actually are, less than in the smaller ones, and if anything a cheaper grade of material might be used with safety.

Taking up the charges in order as hereinbefore outlined the committee submits its opinions.

A. The question of unsuitable reinforcing material and extravagance in testing the same.

1. Cost of testing. The committee are of the opinion that the cost of testing will not be unreasonable and that in all probability it will be less than a similar service performed by an inspection company.

2. Quality of steel. The committee are of the opinion that the use of rerolled steel in certain parts of the structure was warranted on the grounds of economy and that in view of the relatively high grade of the material the integrity of the structure has not suffered in any particular.

B. In the matter of foundations of the north abutment or retaining wall. The committee are of the opinion that the failure of this wall, from the causes outlined by Ald. ——— is a very remote possibility, and that the wall is safe against failure from the other possible causes outlined in this report. The committee are also of the opinion that the additional cost of carrying this foundation to rock would not be justified by any extra security so obtained.

C. In the matter of employing consulting opinion. The committee were unable to find that any suggestion to this end was ever made by Ald. ——— or anyone else and they also find that if the understanding existed as stated by Ald. ——— it was not made public or communicated to the City Engineer. The committee further are of the opinion that such a course was not justified on the grounds of cost.

After carefully reviewing the statements of Ald. ——— the City Engineer's reply thereto, the record of tests of material, and the plans of the structure, as well as the work itself, and the evidence submitted, the committee wish to state that they can find no reason for the charges and are unable to understand why they should ever have been made.

The full report of the committee was filed with the city authorities and with the secretary of the parent society. The Commissioners and the City Council adopted the report and thanked the society for its assistance. The council of the parent society also expressed its approval of the manner in which the Calgary branch had handled the matter.

The local society has no apology to make for the action taken. On the other hand it believes that it has done a valuable service to the profession and the public in establishing this precedent and that if it was more generally understood that charges reflecting upon the ability of engineers in public office would have to pass the investigation of the local profession, that a great deal of unjust criticism would be avoided and the public relieved of a large amount of unnecessary worry.

SAM G. PORTER,
Secretary-Treasurer, Calgary Branch,
Canadian Society of Civil Engineers.

Calgary, Alberta, May 19, 1916.

Annual Meeting of American Water-Works Association

Evidences of increasing activity and prosperity were displayed at the 36th annual convention of the American Water-Works Association, held in New York City, June 5 to 9. With a treasury surplus of over $7,000, of which $4,000 has been invested in permanent securities, the association faces its most promising year. The gain in active membership during the last year—94 net—is also encouraging. Some 400 to 500 active members attended the convention; and the 60-odd manufacturers who had exhibits of water-works supplies and equipment made the convention a notable and attractive one. The total registration was about 1,200.

The address of the retiring President, Nicholas S. Hill, Jr., gave a summary of the year's work. He stated that the most useful field for the association was in committee work and suggested that the committees be distributed geographically instead of following the usual practice of distributing the membership on the committee geographically, for this would afford a better opportunity for committee members to get together. He recommended that as much of the funds available as possible be devoted to committee work by means of a regular budget system ($500 has been appropriated for the present year). He further recommended closer cooperation between the local sections and the parent society and the publication of a bi-monthly instead of a quarterly "Journal," as soon as funds would permit. The latter part of his address was an answer to editorial criticisms of the association in this and other engineering periodicals, an abstract of which appears elsewhere in this issue.

Election of Officers—Next Convention City

Leonard Metcalf, of Metcalf & Eddy, Consulting Engineers, Boston, Mass., who has recently completed his term as President of the New England Water-Works Association, was the unanimous choice for President. The keynote of Mr. Metcalf's brief address in accepting the presidency was closer coöperation and greater service of members of the association. He recommended the formation of local sections as one of the best means of accomplishing these ends.

The other officers elected are: Vice-President, Theodore A. Leisen, General Superintendent of the Board of Water Commissioners of Detroit; Trustees, F. W. Cappelen, City Engineer, Minneapolis, and M. L. Worrell, General Manager Water-Works, Meridian, Miss.; Treasurer (reëlected), James M. Caird, Chemist and Bacteriologist, Troy, N. Y.

The vote for the city in which to hold the next convention aroused the usual amount of interest. The final ballot, to the great joy of E. E. Davis, was for Richmond, Va., with 113 votes. St. Louis was second with 59 and Birmingham, Ala., third with 29.

Water Consumption and Water Waste

The committee on water consumption reported briefly that the present forms for water consumption were being revised to group similar conditions and separate manufacturing and domestic consumption. A paper "Prevention of Water Waste on Railroads," by C. R. Knowles, described what had been accomplished by one railway (the Illinois Central) by proper attention to this item of operating expense—an annual saving in its water accounts of nearly $35,000. The discussion included water waste in general and the need of bringing home to the consumer the actual cost of water waste to him individually.

A closely allied subject, the question of what percentage of a city's total water-supply should be accounted for, received a considerable part of the time devoted to superintendents' day. The general consensus of opinion seemed to be that when 70 to 75% of the water leaving the water-works was accounted for, the results were all that could be expected. Nevertheless, several instances were given, notably Cleveland, Ohio, where 88 to 90% of the water delivered to the mains was actually accounted for. This required that the city or town be 100% metered and that the water used for fires and street flushing also be fairly accurately measured.

Reports and Discussions on Standard Specifications

The committee on standard specifications for hydrants and valves reported that it was coöperating with a similar committee from the New England Water-Works Association and that the specifications of the two associations were now practically identical except for 4-in. hydrants. The revised specifications of the committee were adopted. The committee on standard fittings for water meters has fixed over-all meter lengths for meters up to 1½ in. The report was accepted and the committee continued.

Pumping machinery received a fair amount of discussion. A paper "Pumping Machinery; Test Duty versus Operating Results," by J. N. Chester, Pittsburgh, Penn., called attention to the usual inefficient operation of boiler and piping plants and the need of a high-level reservoir to make loads uniform. He said there should always be a thorough study of local conditions before adopting electrically driven pumping machinery.

Discussion of Pressure Filters

The paper "Pressure Filters," by Harold C. Stevens, was a remarshalling of the old arguments in favor of pressure filters. The discussion showed that there appears to be a certain field for this type of filter, but that the majority of the speakers favored its use only under exceptional conditions. A point urged was that chlorination as a supplementary process puts pressure filters on as safe a basis, bacterially, as those of the gravity type.

The chief economical use of pressure filters appears to be confined to small water supplies where one set of pumps can be eliminated and where preliminary coagulation and sedimentation are not necessary. Lack of proper supervision of these small plants was held to be a prime cause for the disrepute into which pressure filters have fallen.

A water-works convention without a discussion of the merits of leadite for water-main joints has become a thing of the past. The evidence developed at this meeting proved to be quite entirely in favor of the use of leadite. A paper by William C. Buck, "Experience with

Leadite in Jointing Cement-Lined Water Pipe," described in minute detail the method of handling and applying this material to obtain the best results. In answer to several questions, he stated that no difficulty was experienced in cutting out old or defective joints. For this purpose he had devised a special tool. The poor results which have sometimes been obtained with leadite were held to be largely accounted for by the prejudice of the old-time lead calkers. For this reason it was recommended that trained lead calkers be not employed when leadite was used, but that new men be specially trained in pouring joints with leadite.

Paying for Private Fire Service

Practically all of the first session of the superintendents' day was devoted to a discussion of nine questions regarding private fire services, most of which related to the mooted question of charge or no charge. The insurance companies were well represented and the discussion at times was quite animated. Few of the queries developed any definite answers which could be agreed upon. The insurance representatives did the most talking. Finally, a motion was passed to limit the remainder of the discussion to water-works superintendents. The superintendents seemed generally agreed that a 4-in. connection was ample for 400 sprinkler heads, and that $50 a year was a normal charge for a 4-in. connection. They also seemed of the opinion that the sprinkler service was a special service and should be paid for as such. There was, however, increasing evidence of a getting together spirit on the part of the insurance interests and the water-works men, and a committee of the Association will be appointed to work toward that end.

The paper of Dabney H. Maury on "Reservoirs" was a frank statement of several years' experience, going into details of construction of several of the reinforced-concrete type. This led to a general discussion of the subject of concrete reservoirs and experience in attempting to waterproof them.

Presentation of Data on Reduction in Typhoid

George A. Johnson, New York City, presented data showing the effect of the introduction of water filtration and other sanitary measures in reducing the typhoid death rate during the last 25 years, together with such convincing arguments in favor of water filtration that a motion was passed by the meeting to have the paper printed separately and made available for general distribution.

Mr. Johnson's proposal that state public health departments should accept plans for "any method of purification, tangibly guaranteed continuously to furnish a water complying with the law," met with stout resistance from several members.

The report of Prof. Albert F. Ganz, Chairman of the Committee on Electrolysis, stated that an increasing amount of damage to water mains was occurring and that street railways were the sole cause of it. The connecting of the rails to water-mains to furnish a return circuit was unreservedly condemned. He argued that the water-works officials should join hands with the other interested public-utility men in agreeing on the methods of mitigation. In the discussion on the report strong opposition to working with the Joint National Electrolysis Committee was expressed. This was pased on the fact that the committee includes street railway and allied public-utility interests and on the fear that the Association might in some way commit itself so as to render the collection of damages from electrolysis more difficult. The report of the committee was accepted, instead of being adopted. The convention also voted to continue the committee, but not until it was made clear that the membership might be changed if the Executive Committee of the Association sees fit.

E. P. Goodrich, of New York, presented a lengthy report on the features of water-works design which affect city planning. These mainly involve the joint use of lands for reservoir sites and parks, and the advantage of underground hydrants in cities which had no snowfall. The failure to find hydrants in the winter when covered with snow has been found to be the only really tenable argument against the adoption of underground hydrants.

Chemical and Bacteriological Section

Two well attended lively sessions were testimony to the wisdom of establishing a section for the chemists and bacteriologists. A half-dozen papers were presented. Charles P. Hoover, of Columbus, Ohio, was elected Chairman and John A. Kienle Secretary of the session.

Something new which promises to be of economic value at certain water-treatment plants was presented by Charles P. Hoover, in a paper on "Recovery of Spent Lime at the Columbus Water-Softening and Purification Works." Experiments indicate that by building and operating a $30,000 lime-recovery plant $9,000 a year can be saved, and the problem of preventing the choking of the Scioto River with lime sludge may also be solved. The general plan is to reduce the moisture content of the lime sludge (1) by means of settling basins and (2) by vacuum filters, after which the sludge is put through rotary kilns and thus recover (except when the sludge is muddy) more lime than was used to soften the water. When the sludge is muddy lime recovery will not be attempted. Instead, limestone will be burned to produce lime.

A sewage effluent better than the Croton water into which it is turned three miles above the aqueduct intake was described by T. D. Coffin and Frank E. Hale, of the Department of Water Supply, New York City. The plant was built and is operated by the City of New York to treat the sewage delivered to the plant by the village of Mt. Kisco. It includes bar screens, pumps, a grit chamber, settling tank, dosing apparatus, double contact beds, intermittent sand filters and chlorinating apparatus. It treats 200,000 to 600,000 gal. of sewage per day. The original cost was $70,000. The total bacterial reduction is almost 100%—but 20 p.p.m. of available chlorine are used after sedimentation, double contact and slow sand filtration.

The abolition of the presumptive test for B. coli, unless accompanied by confirmatory tests, was advocated by C.-E. A. Winslow, of New Haven, Conn., after reviewing late researches on the subject. Conservative views as to the wisdom of doing this were expressed in the discussion.

Less objection, in fact well-nigh aproval, was given to the proposal from another source to abandon the time-honored term, temporary hardness, and use alkalinity instead. The section finally decided to recommend the matter to committees of the American Chemical Society and the American Public Health Association.

Aims of American Water-Works Association Voiced*

By Nicholas S. Hill, Jr.†

SYNOPSIS—A presentation of the "broader aspects of the development" of the American Water-Works Association in form of an answer to a discussion started editorially in "Engineering News" of May 20, 1916, under the caption, "Can the American Water-Works Association Find Itself?" and "What Is Wrong with the American Water-Works Association?"

Is it surprising that we have not found ourselves amid the world-wide chaos of changing customs, ideals, morals and beliefs? Would it be well if we rested complacently in the belief that we had found ourselves? Is it not better never to find ourselves and to hold the illusive goal of perfection ever before us as an incentive to greater and better accomplishment? Our Association has not been unaffected by the spirit of change which is rampant everywhere. This convention is fraught with the significance of change.

I well remember the convention of 1901 at the Murray Hill Hotel in this city. The meeting room was little larger than the room used for your Executive Committee at this convention. This small room was not more than half filled by those in attendance to listen to the papers. The membership could be found in the cafe at any time of the day or night in a more or less stimulated state of exhilaration. The exhibits were insignificant and typical of that lack of the application of scientific study to water-works details which was apparent for so long. The individual evidenced an almost complete absence of the sense of personal responsibility to the association. Compare that with the present and we have a vivid picture of change in ideals and aspirations as well as of the progress which we have made toward finding ourselves. From a mere handful of men we have developed a regiment of soldiers. From an obscure, heterogeneous body we have produced a recognized, stable and respected association. I think we are criticized too often for our past, and there is a common tendency to misinterpret our present aims, to stress our externals and to overlook our true spirit.

But what is wrong with us? The failure of this association is not more conspicuous than that of other organizations or societies, and springs from the same cause. It does not meet the individual need, and the individual is not called upon to do enough for it. Those familiar with the work of our engineering societies have agreed that the original aims of these organizations are not completely satisfying at present. It is not sufficient to organize, hold conventions, elect officers, read papers and publish proceedings. All of these things are necessary, but they are not adequate. The instruction of the individual is not sufficient. Something must be done to help him in a more material sense. If this is true of the strictly engineering societies, it is more so with regard to this association. Broadly speaking, we are a technical society, but one of the chief aims of this association is to benefit the superintendent. The greatest benefit which we can render to the superintendent is to assist him toward honest endeavor, efficiency and capability in his office; to stand behind the intelligent, sober and industrious water-works man. Our greatest care should be that his badge is a certificate of character, responsibility, efficiency and power. The plan will naturally entail more difficulty than the present method of allowing every member to shift for himself. If, however, the individual felt the strength of the association behind him he would be a better official to the everlasting benefit of the community he serves.

It has been stated in the articles referred to that the prospect of a junket is more alluring to the average member of this association than the opportunity to add to his knowledge of the water-works business. We are accused of being more interested in voting for the next place of holding a meeting than in anything else; that we resent the adoption of businesslike methods of electing officers because we fear that by the adoption of such methods we are losing some of our vested rights; that there is a strong tendency toward the formation of cliques and factions; that the operating men resent the active part taken in the management of the association's affairs by technically trained men, and that there is an over-ambitious attempt at expansion.

I wish at this time to make public denial of some of these charges.

I do not believe it is true that the prospect of a junket is more alluring to the average member than is the opportunity to add to his knowledge of the water-works business. I know of no convention where more earnestness is displayed, and where the business sessions are more generally and conscientiously attended than are those of this association.

Nor do I believe that we are more interested in voting for the next place of meeting than in anything else. The session at which the next meeting place is selected is the only one which brings all classes of members together, and there is a natural rivalry between the friends of this place or that, which of itself portrays an excess of interest which is more apparent than real. There are certain features of this session which furnish a little variation to the humdrum round of technical papers and consequently there is a general relaxation on the part of all.

In this connection, however, I do not believe that the function of the Committee on the Selection of the Next Place of Meeting, which has been in existence for the past few years, has been understood. It was not the idea that this committee should select a place of meeting, nor appropriate any of the functions of the voting membership, but that it should report its findings to the convention so that it might make an intelligent choice between the invitations extended and not be governed solely by the spellbinding efforts of some orator who is given the privilege of the floor.

*Portions of the presidential address before the American Water-Works Association, New York City, June 6, 1916.

†Consulting Engineer, 100 William St., New York City.

I believe that every member of this association recognizes that the motives which should govern the selection of a meeting place are: 1. Consideration of the growth and development of the association which will be brought about by the selection. 2. The educational benefit which will be derived from the selection. 3. The facilities which will be offered for the proper transaction of the business of the convention and the comfort and happiness of those who attend. 4. Last and least, consideration of the amusement features which will be offered to those who attend.

The appointment of this committee was solely for the purpose of having representatives of the voting body calmly and judiciously to weigh the merits of the invitations offered, to crystallize the facts, and suggest which of the invitations most nearly fulfilled these requirements.

Neither do I feel that our members resent more businesslike methods in choosing officers, but rather that there is an honest dread, which is inherent in every American, lest this association become undemocratic in its administration and that its powers be usurped by a few individuals who will use it for their own specific purposes. The entire discussion of the proposed change in method of electing officers at the Cincinnati convention indicates this, and I, for one, do not feel that the democratic spirit is one which will in the long run work any injury to the association.

While there may be some who honestly believe that officers should be nominated on the floor of the convention and chosen in the old-fashioned way, I believe that the majority appreciate that the business of an organization of fifteen hundred men cannot be conducted in the same way that an organization of three hundred would handle its affairs, and in order to expedite the work of the convention it is necessary to delegate some of the powers of the individual to representatives chosen in a fair, open and democratic way. The mode of electing officers in 1890 is not adapted to the needs of 1916. To revert to the method of electing officers on the floor of the convention will not in any way lessen political activity or the desire for selfish gains if such motives are present in our ranks.

I regret to say I must admit there is some justice in the charge that there is a tendency on the part of some to separate the membership into classes, which tends to the formation of cliques and factions, but in this we are no different from other organizations. It is, however, most unfortunate for this association that the question of the profession or occupation of the member should be referred to in connection with his appointment for office.

As I see it, this association is composed of three coordinate branches: 1. The engineer and technical man. 2. The water-works superintendent, who may or may not be a technically trained engineer. 3. The manufacturer. Of these, the first two form the active voting membership and are eligible as officers of the association, and the third composes the associate membership. Each of these divisions is capable of performing a service for the association. The engineer brings to the water-works superintendent the result of his highly specialized experience. The water-works superintendent gives to the engineer the benefit of his practical experience in the application of the technical advice of the engineer. The manufacturer demonstrates to both the latest development in those devices and appliances which are useful alike to the engineer and to the superintendent. There is no reason for conflict more than there is reason for conflict between an army and navy enlisted in the common cause of defending their country. The three branches of this association are coördinate. They should be coöperative and not antagonistic. The development of the narrow spirit which invokes antagonism between the three coördinate branches is a parasite which, unless immediately choked, will sap the very life blood of the parent upon which it preys. The future of this association will be hampered if such a spirit continues.

Finally, I disagree with the statement that the complete nationalization of this association is beyond the realms of possibility. I do not believe that we can be over-ambitious in our attempts at expansion. I should like to see every worthy water-works man in the United States enrolled as a member of this association. The only way in which the mass of those who are in charge of the smaller works in this country may be reached is through the formation of local sections. Sectionalization brings added burdens, I admit, but I believe that we should accept these burdens in the name of service, manfully shoulder them, and solve the problems antecedent to complete nationalization.

The issue of a single, country-wide association was raised by my predecessor, and everyone who has a disinterested regard for the welfare of the water-works fraternity should weigh its merits and disadvantages carefully. There is much to be said in favor of a single association. It would cut the cost and time required in attending conventions in half. It would lessen individual expenses for dues. It would minimize the cost of publications. It would facilitate the classification of our technical literature. It would reduce the demands upon the time of those who prepare technical papers. It would coördinate committee work and standardize specifications. It is fair to assume that one large national organization would wield a stronger influence in moulding public opinion than would several smaller bodies. A national water-works association has a great opportunity to direct public opinion in proper channels when legislatures are about to enact laws which vitally affect such matters as stream pollution, the powers of state boards of health, the purity of drinking water, and the protection of watersheds. It could educate the public upon the necessity of placing costly water plants in the hands of skilled and qualified men without regard for the political affiliations. It could, as suggested, aid and abet worthy members in resisting the influences which all municipal employees realize are at work to reduce the efficiency which they are striving to attain.

When a national association is mentioned, some say that its size will destroy the intimate personal relation which has been one of the most valuable assets of the smaller organizations. It is at this point that the sections become useful. It must be remembered that under our present system the larger organization is composed of smaller units, each holding its own meetings at regular intervals. These sections offer an adequate means for close contact among members and insure acquaintanceship for the member who attends the national convention.

Sooner or later the question of one national association must be definitely decided. There is ample time for

thought in the interim, but provincial barriers and petty ambitions must be cast aside and the outcome must be founded upon a broad-minded view of the whole situation considered alone from the viewpoint of the greatest good to the water-works profession and from the standpoint of service to the country at large.

Preparedness is the order of the day, and we must be ready to meet the question of nationalization when it becomes an active issue, as it surely will. We will not find ourselves until we decide whether we are to be a great national organization or a narrow association developed through narrow considerations and a narrow attitude toward our fellow members. We must make this body as strong as its convictions. It matters little what our ideals may be and what achievements we may hope for if these ideals and achievements cannot be reduced to action. The events of the past and the events of the day show that ideals amount to nothing if we lack the power to maintain them against opposition.

It is pertinent to ask at this point: What should be the ideal of this association? My answer is, Service. Service of the individual to the association. Service by the association to the individual and to the country at large.

What is needed primarily is individual service, as the corporate service of the association is nothing more than the composite service of the individual. What we need, therefore, is servants, irrespective of calling or profession, servants who are willing to do and to help achieve the best results for the association. Servants who are simple, honest men, with a fellowship of interest, an *esprit de corps,* and a decided discipline; men who are interested in the actual work they are doing, for whom work itself is in a measure its own reward, in whom the instincts of workmanship, of control over brute things, the desire for order, the satisfaction of service rendered and uses created, and the civilizing passions are given a chance to temper the primal desire to have, to hold, and to conquer.

Must Give Pure Water Before Earning Fair Return

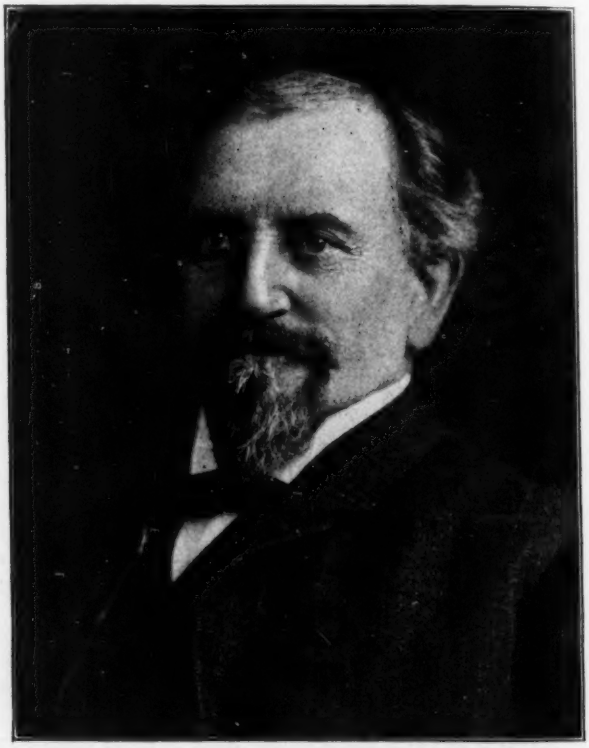
A water utility must give an adequate supply of pure and wholesome water, even though its revenues are insufficient for the purpose, is the recent ruling of the West Virginia Public Service Commission in the case of the Montgomery Light and Water Improvement Co. (Case No. 421; Pub. Util. Rep. 1916 C 406.) It was held that this company, being in the business of supplying water to the inhabitants of Montgomery and in collecting revenue therefrom, could not escape the obligation of furnishing a pure and wholesome supply and could not be heard to say that its revenue was not sufficient. The commission stated, however, that once a pure supply had been furnished it would permit rates securing adequate revenue. Separate proceedings then will presumably be required to establish the inadequacy of the earnings.

A schedule of meter rates was worked out, but ordered suspended until the better supply was given. For these rates a return of 7% on a plant value of $23,000 was allowed. For depreciation-compensation on the poorly constructed plant 5% per annum was allowed. Wages and expenses were set at $5,000, making the total necessary revenue $7,760. It was estimated that a step[illegible] scale, as follows, would give this return:

Minimum, with consumption of 1,500 gal.	[illegible]
Next 1,500 gal. (per 1,000 gal.)	[illegible]
Next 2,000 gal. (per 1,000 gal.)	[illegible]
Next 5,000 gal. (per 1,000 gal.)	[illegible]
Next 5,000 gal. (per 1,000 gal.)	[illegible]
Next 5,000 gal. (per 1,000 gal.)	[illegible]
Next 10,000 gal. (per 1,000 gal.)	[illegible]
Next 20,000 gal. (per 1,000 gal.)	[illegible]

Henry Rohwer

Henry Rohwer, M. Am. Soc. C. E., an engineer widely known in the West in connection with railroad construction, died at his home in St. Louis, Mo., on May 4, at 68 years of age. He was born in Holstein, Germany,



HENRY ROHWER

Mar. 17, 1848, and was a graduate of the Jessen Polytechnic Institute at Hamburg and the Royal Polytechnic School at Hanover. Following his graduation from the latter, in 1869, Mr. Rohwer came to the United States, and was immediately engaged on the construction of the Burlington & Missouri River R.R. lines in Nebraska, serving in various capacities from topographer to chief engineer of that railroad.

In 1875 he entered into private practice as a consulting engineer and architect in Omaha, Neb., of which city he was appointed city engineer in 1877. In 1881 he left the service of the city to become engineer in charge of location and construction of the Oregon Short Line, including Hodges Pass Tunnel, and in 1884 resumed his consulting practice in Omaha, which he continued for about a year.

From 1885 to 1887 he was engineer in charge of location and construction of the Omaha Belt Ry. and the Missouri Pacific extension to Lincoln, Neb., and from

1887 to 1901 was engineer of maintenance-of-way of the Missouri Pacific System and its branches. In 1901 he was appointed chief engineer of the Missouri Pacific and the St. Louis, Iron Mountain & Southern Ry., which position he held until 1905, when he resigned to take up consulting engineering in St. Louis, Mo.

During the past ten years Mr. Rohwer had made many important investigations and reports on railroads, waterworks, power plants, etc., both in the United States and in Canada. He was employed by the City of St. Louis, and made a report on the "Selection of Site for Municipal Free Bridge" in 1907. It has been said that he superintended the construction of more miles of railroad than any other engineer in the United States. He was in charge of the construction of a $4,000,000 railway enterprise in Georgia at the time of his death.

Baltimore Experiments on Grease from Sewage

Experiments to determine the amount of grease in the sewage of Baltimore, Md., and the percentage of the grease which was saponifiable and non-saponifiable were made in 1915 during a period of two and a half months, at the Back River sewage-disposal plant of that city. The following concise account of the nature of the experiments has been supplied to *Engineering News* by Calvin W. Hendrick, Chief Engineer of Baltimore:

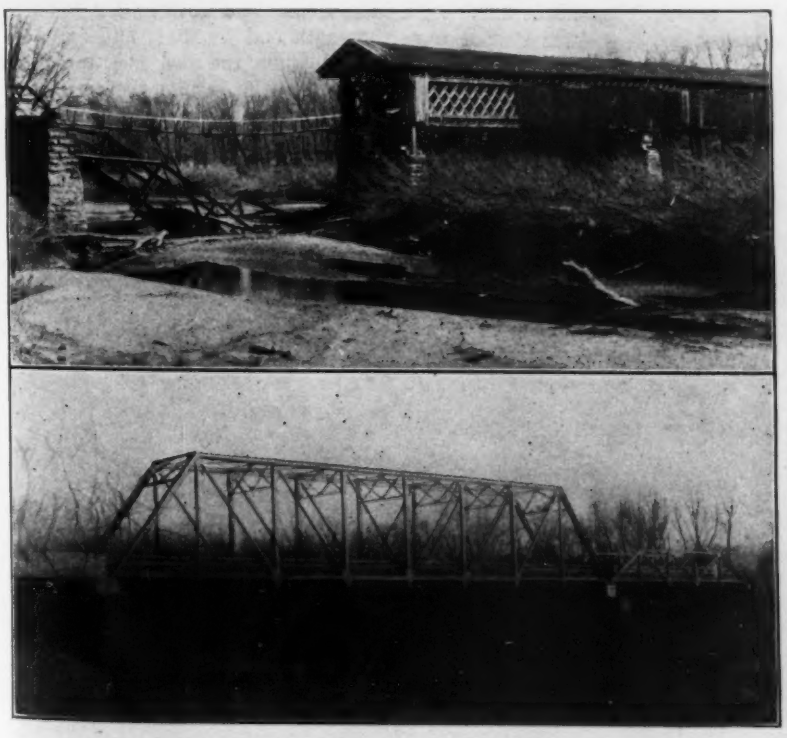
A circular tank was supplied with raw sewage by a pump, the suction pipe of which was led into a long box having a slot cut in the side extending from the surface to a point 4 ft. below the surface. The pump discharged into a constant-head weir box which was used to control the flow. The sewage flowed from the weir box into a lead funnel into which was also fed the sulphuric acid. A lead pipe led from the funnel to the tank and entered at a point 1 ft. from the bottom. The inside end of this pipe was bent laterally to impart a slow circular motion to the sewage. The acidified sewage was drawn off at the top through a weir with a baffle in front of it. The flow was regulated to give a retention period of five hours.

During the time the experiment ran 24 cu.ft. of sludge accumulated, which was found to contain 27.5% grease on a dry basis. Of this 27.5%, 86.34% was saponifiable and 13.66% non-saponifiable grease. The sludge obtained had a very offensive odor and contained 93.9% moisture. It was very hard to dry on a sand bed; in fact, after 48 days in summer weather it still retained 66.8% moisture.

An account of grease removal experiments at Boston, Mass., was printed in *Engineering News* of May 11, 1916, p. 813, and some comment on these other experiments in grease removal appeared May 25, on p. 1005.

An Old Timber Bridge and Its Modern Successor

An old-time timber-truss highway bridge over the Spoon River in Bernadotte township, Fulton County, Illinois, has given place to a modern structure that includes both steel and reinforced-concrete spans. The accompanying views show the old bridge after a partial washout and also the new bridge, which was opened to traffic in January, 1916. Information has been furnished by G. F. Burch, Assistant Bridge Engineer, Illinois State Highway Department, Springfield, Ill.



OLD TIMBER BRIDGE AND ITS SUCCESSOR

Upper view shows old two-span timber truss and washed-out steel span. Lower view shows new structure with two steel truss spans and concrete girder span

The old structure consisted of a timber truss, with two spans of 80 ft. and 76½ ft. c. to c. of piers, and a 24-ft. roadway. The trusses, the stone piers and abutments were built in 1845. The remainder of the bridge consisted of two steel-truss spans of 76½ ft. and 32 ft. with 20-ft. roadway. These were built in 1895. In the spring of 1915 the bridge was damaged by flood, as shown in the upper view. It was decided to reconstruct the bridge at the joint expense of the state and county. The stone piers and abutments were found to be generally in good condition and it was decided to retain them in the construction of the new bridge, which consists of a 30-ft. reinforced-concrete through girder span, a 155½-ft. steel span and a 75-ft. steel span, all having an 18-ft. roadway. One of the old piers (shown in the center of the upper view) was found to be in poor condition and was removed. This resulted in a longer span over the main channel. The old stone piers and abutments were pointed up and capped with concrete to bring them to the proper elevation to support the shoes of the new structure.

News of the Engineering World

Pittsburgh May Have Transit Commissioner

The Public Service Committee of the Pittsburgh City Council has prepared an ordinance enabling the mayor to appoint, with the approval of the Council, a commissioner to report on a rapid-transit system. This action followed renewed local agitation for rapid transit culminating in a preliminary survey gratuitously made by A. M. Taylor, late transit commissioner of Philadelphia.

The encumbent of the new office, in case the Committee's ordinance is passed by the Council, will be selected after a conference of the councilmen, mayor, city law department, and the Engineer's Society of Western Pennsylvania.

"Personal Safety First" Aids Albany Collision

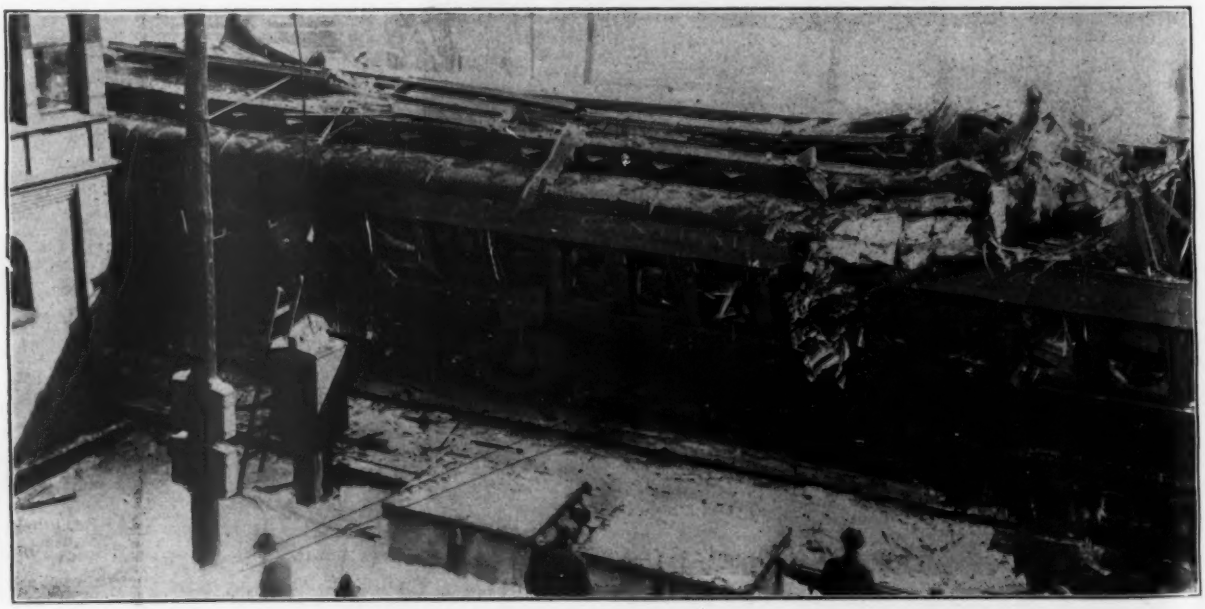
The Coroner's report of the rear-end collision between a New York Central coal train and a train made up of express cars on the Broadway viaduct, Albany, N. Y., on Mar. 3, states that if the brakes of the freight had been set properly in descending the hill to the viaduct, the accident would not have occurred. The report states further that from the evidence of the crew of the freight train the brakemen were practically green men, and the engineman's cab experience dated only from Dec. 25, 1915. The engineman lost control of the brakes and perceiving that a collision was imminent he jumped.

Personal-safety first seems to have been the underlying cause of the collision, together with too big a train to be handled by other than a veteran railroader. It is the opinion of many old railroad men that 50 cars is about the limit to which the emergency brakes will be effective unless the retaining valves are set to hold air back of the brake pistons. On the freight which ran into the express-car train there were 98 cars, and it would probably have taken the brakemen ten minutes to cover the train and set the retainers at every fifth or tenth car, which is the ordinary practice.

On the rear of the express train were two day passenger coaches, one of steel and the other of wood with steel underframe. In the collision these two coaches telescoped, as illustrated in the view.

Marseilles-Rhone Canal Not Yet Finished

Evidently there was an error in the announcement of the opening of the Marseilles-Rhône canal tunnel which was recently widely circulated in the American press following dispatches from France, and which was noted on page 917 of *Engineering News*, May 11, 1916. From a recent article in *Le Genie Civil* it appears that one of the two advance headings was holed through on Feb. 18, 1916, and that the celebration which took place on May 7 was in honor of that event. This heading is about 80 sq.ft. in cross-section, whereas the whole tunnel is about 3,060 sq.ft. in section. The work on the headings was started from the south end in 1911, and from the north end in 1914, and when the two met the south heading had advanced 15,446 ft. while the north had advanced 8,392 ft., the tunnel being over 5 mi. long.



WHAT A STEEL CAR DOES TO A WOODEN ONE WHEN IT TELESCOPES IT

While the work is still going on, the progress of late has necessarily been retarded by the war. With the aid of war prisoners, however, the contractor is able to make some headway and it is stated that the project will be completed some time in 1919.

Memphis To Have $1,500,000 City Electric Plant

F. W. Ballard, the representative of the City of Memphis, Tenn., in the appraisal of the Merchants Power Company's plant, has reported to the Board of Commissioners that efforts to select a third arbitrator have proven unavailing, and he has recommended that the city proceed with the construction of a plant, as provided by the terms of a recent $1,500,000 bond issue. He reported that the city could sell current at 5c. per kw.-hr. and that it is probable that production cost will be 3c.

The State Supreme Court recently handed down a decision sustaining the validity of these bonds, which were contested on various technical grounds.

Higher Court Affirms Decision Against Thacher Patent

The Federal Court of Appeals for the Second Circuit, Judges Cox, Ward and Chatfield sitting, on June 7 affirmed the decision of Judge Thomas of Jan. 8, 1916, in favor of the Transit Construction Co., which had been sued by Edwin Thacher for infringement of his United States Patent No. 617,615 "for new and useful improvements in concrete arches." As noted in *Engineering News*, Mar. 23, 1916, p. 580, the lower court decision hinged on the question of the independence of the upper and lower rods in the reinforcement of the arch. The decision virtually holds that the essential feature of the Thacher patent is the independence of these two planes of rods and any arch in which there is a direct and substantial connection between the two can not be claimed as an infringement of the patent.

ENGINEERING SCHOOLS

University of California

The College of Chemistry has established a new four-year course in chemical engineering.

The College of Mining has reorganized its curriculum so that hereafter students may with the beginning of the sophomore year elect professional training in mining engineering, metallurgy, economic geology or petroleum engineering. Two new courses will be added next year to the instruction for oil engineers. One will be a course on petroleum cost accounting and the other a course in which will be taken up special technical problems connected with the production and transportation of oil.

University of Wisconsin

An exhibit of mechanical fittings and valves has been given to the College of Engineering by the Crane Co., Chicago, for demonstration purposes. It will be used for exhibition to the students in the electrical, chemical and mechanical departments. The display has been temporarily placed in the gallery of the steam laboratory and will be open to inspection by the public. About 85 pieces are included in the collection. The larger pieces are mounted on nickel-plated cast-iron pedestals with the upper part swung on ball bearings. They are all quarter-sectioned, to show the inside. Most of the smaller pieces are sectioned and mounted on nickel-plated mountings, and are exhibited in a stand with plate glass front. Purdue University, the only engineering school in the country which possesses a collection equal to it, received its exhibit from the same company.

NOTES

Reinforced-Concrete Piers on the ocean pier at Ocean Park, Calif., were not harmed in a recent fire which destroyed the wooden superstructure. Although the concrete was subjected to intense heat it is still in sufficiently good shape so that the piers can be used in the reconstruction without patching.

A Demonstration of Fire-Retardant Treatment for wood was made at the Forest Products Laboratory at Madison, Wis., during a visit of the National Lumber Manufacturers' Association. Two small houses, one of treated wood, the other of plain wood, were subjected to a high-heat exposure, and the untreated house burned while the other merely charred.

The Austin Dam, across the Colorado River at Austin, Tex., is once more under investigation. Bartlett & Ranney, consulting engineers, with offices at San Antonio and at Dallas, Tex., have been engaged by the City of Austin to make a thorough inspection of the dam. The present investigation is for the purpose of comparing the structure with what it would have been, if built as originally designed, together with a report upon the comparative cost and stability.

The Semaphore System of Regulating Street Traffic will not be used in Boston, although the street commissioners believe that it would help relieve congestion in the down-town streets, basing their opinion on the success of a fixed semaphore which was tried out at the corner of Tremont and Winter St. Their decision is the result of a letter from Police Commissioner O'Meara to the effect that he believes that semaphores would delay rather than expedite traffic, and that he would not authorize his men to operate them.

A Movement To Organize an Engineers Union in Australia appears to have met with little success. The "Commonwealth Engineer" of May 1 publishes a letter, the writer of which declares that many professional engineers in Australia are earning only 12½ to 15 shillings per day, while foremen and first-class trade union men earn 17 to 20 shillings per day, and he urges the organization of an engineers labor union. In connection with the publication of the letter, however, it is stated that a proposal to form an engineers union was brought before the Registrar of the Queensland Arbitration Court, and the application was refused.

Railway-Valuation Work has been in active progress on the Cleveland, Cincinnati, Chicago & St. Louis Ry. During last summer and fall there were engaged in this work four track and roadway parties, two terminal roadway parties, two bridge parties, a signal party, two building parties, a telegraph party and several mechanical parties. The work of taking the inventory was completed in 1915, except for the buildings on about 300 mi. of line. Since then the company's engineering forces have been engaged in perfecting new maps and profiles and making a check on the inventory notes made by the Interstate Commerce Commission.

A Contract for Pavement and Sewer Construction in Havana, Cuba, held by the McGivney & Rokeby Construction Co. of New York City, has been abandoned by the contractors, according to a cable dispatch from Havana to the New York "Times," dated May 29. The contract involved work amounting to some $15,000,000. For nearly a year past investigations have been in progress which have revealed serious defects in the portions of the work completed. The government ordered the contractors to repave many streets where faulty work had been done. Instead of doing this the company decided to abandon the contract and forfeit its bond for $500,000.

Two Thousand Three Hundred Engineers Marched in the "Preparedness Parade" at Chicago on June 3. They were not grouped as members of the various technical societies represented, but marched together simply as a body of engineers. At the head of the division was a company of young

men in field costume carrying transit, levels and rods. The entire parade numbered about 130,000 persons, according to official count. This count was made by two sets of four men each. Each set consisted of two counters and two men with adding machines, the pairs working half-hour shifts alternately. One set counted the total number of persons. The other set counted the number in each division.

A Contract for 700,000 Gal. of Asphaltic Road Oil has been awarded by the Tennessee Department of Highways to Sam E. Finley, of Atlanta, Ga., at an average price of 4.89c. per gal. The larger part of this oil will be used on macadam roads in five counties as follows: Davidson (Nashville), 170,000 gal.; Hamilton (Chattanooga), 100,000; Knox (Knoxville), 100,000; Shelby (Memphis), 200,000; Madison (Jackson), 20,000. The remainder of the oil is to be used in various towns. The state pays for the oil from the proceeds of the automobile tax, the money being returned to the counties in which the tax was collected. The various counties have already bought pressure distributors for applying the oil. A. M. Nelson, Nashville, Tenn., is State Highway Engineer.

Another Reinforced-Concrete Pier is to be built at Baltimore, Md. The Pennsylvania R.R. has one under construction, as recently noted in "Engineering News," and now the Canton Co. is about to build a new structure at Canton, Md., to handle ores incoming from Cuba and Chile. The structure is designed by the Cleveland Dock Engineering Co., Cleveland, Ohio. It consists of a pier 77 ft. long and 600 ft. wide with a side dock wall continuing back on one side for 400 ft. longer, making a 1,000-ft. dock on that side. It will have a reinforced-concrete ribbed floor supported on piles, with marginal end buttresses to retain earth fill. It will carry four railroad tracks and ore-handling gantries. Sanford & Brooks, Baltimore, Md., have the contract for the construction, and the Mead-Morrison Co., of Boston and Chicago, for the ore-handling equipment.

The Vote to Abandon Commission Government at Denver, Colo., two weeks ago will probably have little direct effect upon the management of the public works of that city. The vote was on an amendment to the city charter which provided for a return to the mayor-and-council plan in place of the commission plan. The new mayor has named as city engineer J. B. Hunter, for many years city engineer and latterly commissioner of public improvements. There will be added to Mr. Hunter's duties that of the control of city parks, thus placing in his hands practically everything in the line of public works and city property. The project for municipal ownership of water-works will remain in the hands of the Public Utilities Commission until May 31, 1918. This commission, under the terms of its creation, has now diminished in numbers to a single member, Armour C. Anderson.

Los Angeles Voted No on several bond issues, a new city charter and various alternative charter amendments and other questions on June 6 and voted Yes on the annexation of more territory. The defeated bond issues were $8,000,000 for a municipal telephone system; $1,800,000 for sewage disposal, including treatment works at Hyperion and Los Angeles Harbor; $1,250,000 for fire houses and apparatus; and $300,000 for the Second-Street Tunnel. Proposals to sell Los Angeles Aqueduct water outside the city, instead of adhering to the principle of no city water without annexation, were defeated. The two new tracts to be annexed to the city are known as Westgate, 30,000 acres on and near the coast between Santa Monica and the recently annexed San Fernando district, and Occidental, a much smaller area. Each of these areas voted for annexation by a large majority at an earlier election.

The $2,940,000 Water-Conservation Project at Fall River, Mass., recommended in a report submitted to the City Council in September, 1915, by the Watuppa Ponds and Quequechan River Commission, will not be carried out for the present. The commission has been suspended for the time being and a new board is to be appointed to make further study of the matter. The new commission will consist of three members, one selected by the riparian owners along the Quequechan River, one by the Watuppa Reservoir Co., and a third by the Mayor of Fall River. The project recommended last September ("Engineering News," Oct. 14, 1915, p. 760) provided for four conduits in a single three-story reinforced-concrete structure. These conduits were designed to convey lake water for power, to divert sewage, to turn surface water at will into a pond for storage or into a river to waste, and to convey condenser water into oil-separating and condenser basins. The project, if carried out, would regulate water power for mills, increase the water-supply of the city, abate river pollution nuisance, and reclaim 146 acres of land. Allowing for benefits, the net cost of the project was estimated at $1,000,000. Many citizens of Fall River considered this too high a cost.

Information on the Use of Water Meters is wanted by the Committee on Meter Rates of the New England Water Works Association. The chairman of the committee is Allen Hazen, 30 E. 42nd St., New York City. Reports are desired only for works which are completely metered or nearly so. The information sought includes total quantity of water supplied; how measured and slip allowed; quantity of water recorded by meters or accurately estimated; total quantity of water accounted for; whether services and meters are paid for by works or by customer. In addition there is desired a tabular statement of the number of services, the quantity of water used and amount of water charged for under eight groups of quantities in cubic feet per quarter, beginning with over 3,000,000 cu.ft. and ending in under 1,000. If the records are not kept by quarterly periods, any other period for which figures can be given will do. The committee is primarily interested in three classifications, namely: Less than 10,000 cu.ft. per quarter; between 10,000 and 100,000 cu.ft.; and more than 100,000 cu.ft. per quarter. The ranges of quantities just stated are those which were recommended some time ago by the committee as the basis for a three-class meter system—domestic, intermediate, and manufacturing. The association did not adopt the committee's recommendation for meter rates so based, but instead referred the matter of rates back to the committee for further investigation.

The Chiriqui National R.R. was completed and officially inaugurated for public service, Apr. 22 to 25, by the president of the Republic of Panama, the cabinet and about 100 invited guests from the Cities of Panama and Colon. The railroad extends from the port of Pedregal on the Pacific side of the republic, passing through the City of David and terminating at El Boquete, 3,660 ft. above sea level. Branches to La Concepcion and Potrerillos bring the total trackage to 60 mi. The railroad is notable in the respect that to reach Boquete 10 mi. of 4½ to 5% continuous grade is resorted to. Many sections are of heavy mountain work. The standard of construction has been high-grade throughout—56- and 70-lb. rails are laid on creosoted ties and native hardwood ties. The entire line is ballasted with crushed rock and gravel. All large drainage openings are steel bridges resting on concrete piers and abutments. For the smaller openings corrugated-iron culverts were installed. The motive power consists of Consolidation type 2-8-0 locomotives with 60 tons on drivers. These locomotives are capable of hauling 125 tons at 10 mi. per hr. on the maximum grade of 5%. The studies for the railroads were made by R. W. Hebard & Co., Inc., of 16 Exchange Place, New York City, in 1913, and the same firm undertook the complete construction and equipment of the railroad ready to operate in April, 1916, their contract with the Government of Panama calling for completion by May 1, 1916. A. S. Zinn was consulting engineer for the Government of Panama. The railroad was placed in commercial operation on Apr. 30, R. W. Hebard & Co., Inc., assuming temporarily the management of the property.

PERSONALS

Warren D. Spengler has resigned from the Cleveland Construction Co. to become Construction Engineer for the Goodyear Tire and Rubber Co.'s new building at Toronto, Ont.

W. F. Dozier, who has been employed by the City of Taylor, Tex., on paving work for a year past, has been appointed City Manager, under the new form of government, at a salary of $2,600 a year.

Francis C. Shenehon, M. Am. Soc. C. E., has tendered his resignation as Dean of the College of Engineering, University of Minnesota, to take effect May 1, 1917. Dean Shenehon will open offices for private practice.

C. F. Hamilton, M. Am. Soc. C. E., formerly General Manager of the Northwestern Construction Co., Franklin, Penn., is now engaged in business under the firm name of C. F. Hamilton, Inc., as Construction Engineer and Contractor, with offices in the Franklin Trust Company Building, Franklin.

G. R. Delamater has been made Fuel Engineer for the Steelton, Penn., plant of the Pennsylvania Steel Co., recently acquired by the Bethlehem Steel Co. He will have charge of coal washing, supervision of the coal stock, including coking, bituminous, gas, slack and anthracite coal, coke breeze and miscellaneous matters between the various operating departments and the Semet-Solvay Co.

H. R. Trumbower, of the Department of Political Economy of the University of Wisconsin, has been appointed a Member of the State Railroad Commission to serve during the remainder of the term of Halford Erickson, who recently resigned.

Professor Trumbower is a graduate of Lehigh University and has studied also at Princeton and in the University of Munich, Germany. He has been teaching in the University of Wisconsin since 1910, most of his work having been in the problems of political economy studied in the Course in Commerce and the College of Engineering.

OBITUARY

Sydney A. Butler, who was engineer during the construction of the Denver & Rio Grande R.R. line through the Grand Cañon of the Arkansas, died at Los Angeles, Calif., on June 4. He was 69 years old.

Sir Hay Frederick Donaldson, who perished with Lord Kitchener in the sinking of H. M. S. "Hampshire," June 5, was a prominent engineer. He was a member of the Institution of Civil Engineers and a past-president of the Institution of Mechanical Engineers. He was born in 1856 and was the son of Sir Stuart Donaldson, first Premier of New South Wales.

Lord Horatio Herbert Kitchener, Secretary of War of Great Britain, who with his staff was drowned in the sinking of H. M. S. "Hampshire," off the West Orkney Islands, on the night of June 5, was a graduate of the Royal Military Academy at Woolwich and entered the Royal Engineers in 1871. Between 1874 and 1882 he had charge of extensive survey work in Palestine and the Island of Cyprus. For several years he was head of the Royal Engineers. He had been an honorary member of the Institution of Civil Engineers since 1904.

Chester Bidwell Albree, M. Am. Soc. M. E., President of the Chester B. Albree Iron Works, died at his home in Pittsburgh, on June 3, at 54 years of age. Mr. Albree was born in Pittsburgh. He attended Williston Academy and Worcester Polytechnic Institute, where he received the degree of Mechanical Engineer in 1884. Mr. Albree was an inventor and manufacturer of machinery and mechanical devices, some of which are in wide use in this country. He was Past-President of the Engineers' Society of Western Pennsylvania.

James H. McClure, an old and well-known railway and bridge contractor in the Northwest, died at his home in St. Paul, Minn., on June 5. Mr. McClure is said to have built the first bridge across the Mississippi River at Anoka, Minn. For many years he was one of the contractors on the Chicago, St. Paul, Minneapolis & Omaha Ry., putting up a number of bridges and having charge of the double-tracking of the road from St. Paul to Chicago. Since his retirement, about four years ago, the James McClure Construction Co. has been managed by his son, John H. McClure. Mr. McClure was 74 years old and had lived in St. Paul 40 years.

Anson Dinsmore Houghton, Mechanical Engineer, died at Santa Cruz, Calif., on June 5. Mr. Houghton was a graduate of the University of Maine and was a doctor of philosophy. Mr. Houghton went to California about 10 years ago, previous to which he was in the employ of John D. Rockefeller and was architect and builder of the Rockefeller Hall Library. He also designed the heating and electric-light plants of the University of Chicago. More recently he had been superintendent of industrial training in various schools in the Southern States under the John Slater Fund for the Advancement of Negro Education. He was 51 years of age.

ENGINEERING SOCIETIES

SOCIETY OF AUTOMOBILE ENGINEERS.
June 12-16. Summer meeting (cruise on Lake Huron and Georgian Bay). Secy., Coker F. Clarkson, 29 W. 39th St., New York City.

MASTER CAR BUILDERS' ASSOCIATION.
June 14-16. Annual meeting, Atlantic City, N. J. Secy., Jos. W. Taylor, Karpen Bldg., Chicago.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 14-17. Eighth semiannual meeting. Cleveland. Secy., I. C. Olsen, Cooper Union, New York City.

RAILWAY SUPPLY MANUFACTURERS' ASSOCIATION.
June 14-21. Convention in Atlantic City. Secy., J. D. Conway, 2136 Oliver Bldg., Pittsburgh.

SOCIETY OF RAILWAY CLUB SECRETARIES.
June 16-17. Annual meeting in Atlantic City. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN RAILWAY MASTER MECHANICS ASSOCIATION.
June 19-21. Annual meeting, Atlantic City, N. J. Secy., Jos. W. Taylor, Karpen Bldg., Chicago.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION
June 19-22. Annual meeting in Charlottesville, Va. Secy., F. L. Bishop, University of Pittsburgh, Pittsburgh.

TRI-STATE WATER AND LIGHT ASSOCIATION OF THE CAROLINAS AND GEORGIA.
June 21-23. Annual convention at Isle of Pines, S. C. Secy., W. F. Stieglitz, Columbia, S. C.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
June 22-23. Meeting at Cleveland. Secy., Frank E. Sanborn, Ohio State University, Columbus, Ohio.

NATIONAL GAS-ENGINE ASSOCIATION.
June 27-29. Annual convention in Chicago. Secy., H. R. Brate, Lakemont, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 27-30. Annual meeting in Pittsburgh. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 27-30. Annual meeting in Atlantic City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

The Southwestern Electrical and Gas Association at its 1916 convention elected the following officers: President, F. R. Slater; vice-president, H. C. Morris, and secretary, H. S. Cooper.

The Pacific Northwest Society of Engineers will hold its convention and dinner in the third week of June. The principal address at this meeting will be on the subject of the "Cedar River Reservoir Problem" and the extension of the water-supply of Seattle The last regular meeting was held on May 31, the subject being the "Test of Concrete Floor Slabs.'

The American Institute of Chemical Engineers will hold its eighth semi-annual meeting June 14 to 17, in Cleveland, with headquarters at the Hotel Statler. The usual excellent list of excursions has been arranged to the important industries of Cleveland and vicinity. These include the ore docks of the Pennsylvania R.R., the Cleveland Filtration Plant, the works of the National Carbon Co., and the plant of the National Lamp Works. Among the papers to be presented are "The Cleveland Sewage-Disposal Plant," by R. Winslow Pratt; "The Purification of Sewage by Aëration in the Presence of Activated Sludge," by Edward Bartow, and "Water Powers of the United States," by Herman Stabler.

The American Electric Railway Manufacturers' Association has discontinued its activities for the present. Heretofore it has held an exhibit in conjunction with the October convention of the American Electric Railway Association. This year the exhibit will be handled by the latter organization.

The Electric Vehicle Association of America was recently affiliated with the National Electric Light Association, becoming the Electric Vehicle section of the latter. The section secretary is A. Jackson Marshall, 29 West 39th St., New York City. The sixth annual convention of the Electric Vehicle Association of America, was held last October in Cleveland and the seventh annual meeting would have been held this October. Instead, however, the new section convened with the National Electric Light Association at the recent convention of the latter in Chicago.

The Boston Society of Civil Engineers and the New England Water-Works Association will hold their annual field day and excursion on June 21, the usual ball game will be at Pemberton, Mass., and the dinner at the Pemberton Inn. A steamboat trip will be taken on the regular boat of the Nantasket Beach Steamboat Co. The executive committee of the New England Water-Works Association will meet in the purser's office on the steamer, at 11:30 a.m. A business meeting of the association will take place immediately after dinner.

The Engineers' Society of Pennsylvania, of Harrisburg, has inaugurated a campaign for additional members throughout the state. William B. McCaleb, Superintendent of the Philadelphia Division of the Pennsylvania R.R., is chairman of the committee which is waging a thorough canvas of Pennsylvania engineers. An effort will be made to double the membership of 700 within a month. On account of its location at Harrisburg, the Engineers' Society of Pennsylvania holds a strong position among engineers. Practically every piece of construction work in the state must be acted upon by some department at the State Capitol and this brings hundreds of engineers to the city every month.

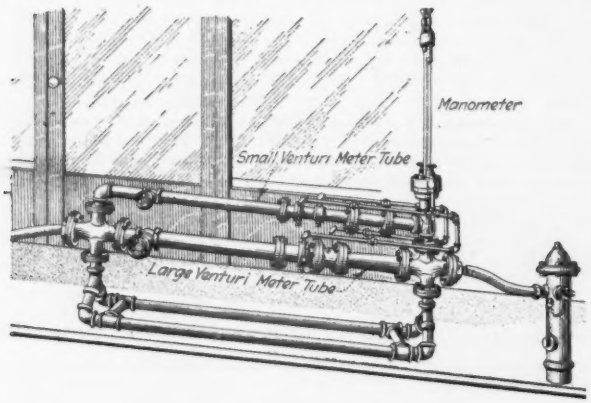
The New York Electrical Society held its annual meeting at the Hotel McAlpin, New York City, on the afternoon of June 14. The officers elected were: President, Putnam A. Bates; vice-presidents, C. E. Scribner, Edwin B. Katte, and W. C. Whiston; treasurer, Thomas F. Monahan; secretary, George H. Guy.

Appliances and Materials

Venturi-Meter Waste Detector

A portable waste detector comprising two venturi tubes and a supporting frame has been designed by the Builders' Iron Foundry, of Providence, R. I., at the instance of Hazen, Whipple and Fuller, Consulting Engineers, of New York City. The first one was made for the City of St. Johns, N. F. As shown in the accompanying sketch, it comprises two venturis of different but overlapping capacity ranges and a mercury manometer—all mounted on a pipe framework. The manometer is a barometric type with the base well connected to the inlet end of each tube and the top interior of the glass tube communicating with the throat chamber. The graduated portion of the tube is 22 in. long. The dimensions of the base of the detector are 17½x80 in. The length is 96 in. over all and the height 20 in. The gross weight is about 800 lb.

In making a leakage test, which is best done late at night when the normal flow is a minimum, the district tested is cut off from the system by the main valves. Then the waste detector is connected by hose between a hydrant outside the district and one inside. The meters then enable the inflow to be measured; the larger tube is tried first and if the flow is too small for good observations the smaller one is tried. By closing gates so as to make the district smaller and smaller the flow in various mains can be deduced.



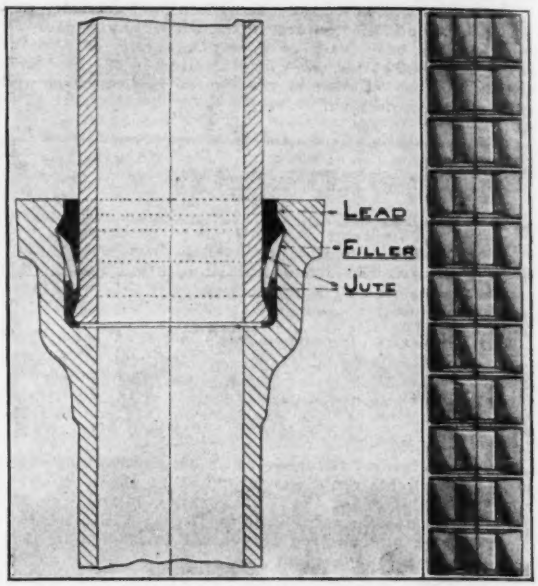
VENTURI WASTE DETECTOR

* * *

Iron Filler for Lead-Pipe Joints

A patented iron filler ring has been devised by the American Cast Iron Pipe Co., of Birmingham, Ala., to save half the lead in an ordinary hub-and-spigot pipe joint. The filler is simply a string of iron wedges cast on a steel wire. In using this device a little jute is first rammed into the joint; then a string of wedges is bent around the spigot and slipped into the hub. More jute is rammed in to force the wedges over into the lead ring of the hub; finally the lead is poured and calked as usual.

It is claimed that added advantages have developed, besides the saving in lead: The lead is more easily forced up into the lead ring; the wedges force the lead into the lead ring when pressure (from water or settlement) comes on the joint, making the latter tighter; greater rigidity is secured in a pipe line but with sufficient flexibility. Tests on a loaded 4-in. joint are reported to have shown a deflection of 7½ in. under a concentrated load of 622 lb., but without leakage under 300 lb. hydrostatic pressure. These "tightening wedges" are guaranteed by the makers to save 50% the usual quantities of lead and to give a more satisfactory joint. There are about 1,000,000 tons of cast-iron pipe used per year in this country and 40,000,000 lb. of lead; at the current price of 7½c. per lb. the saving would be $3,000,000.



FILLER FOR CAST-IRON PIPE JOINTS

* * *

New "Pulmotor" Resuscitator

A new type of "Pulmotor" resuscitation apparatus has been devised by the Draeger Oxygen Apparatus Co., of Pittsburgh. This is designed to eliminate the objections to the older type, which had an uncertain pump control. The principal feature of the new equipment is a control valve that gives accurately measured pressures on the patient's lungs and indicates to the operator the inhalation and exhalation pressures. It is claimed that the new machine can be successfully and safely used by an unskilled operator. It weighs 12 lb., complete with carrying case, and costs $115.

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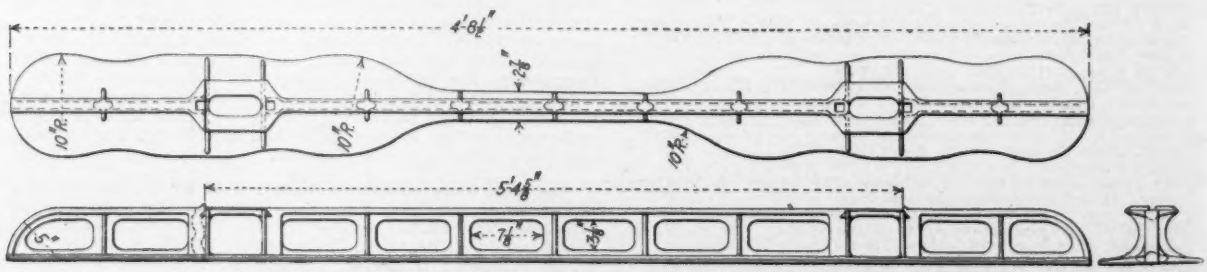
Cast-Steel Crosstie Using Dog Spikes

A new type of cast-steel crosstie is being placed on the market by the Maryland Crosstie Co., 627 Munsey Building, Baltimore, Md. It is a single annealed basic-steel casting and for standard-gage railways is made with a base flange 10 in. wide at either end, but with the width decreased in the middle portion of the tie to prevent center binding or floating of the tie when supported in the center, but not on the ends. From the center of the base flange a skeleton vertical flange projects upward to a height of 5 in., and upon this are provided suitable rail seats. The rail is kept from spreading by a shoulder at the outer edge of each seat. For standard gage the tie weighs 125 lb.

On either side of the rail seat a hole is cored through the entire depth of the casting. This hole is provided with cast lugs upon either side, so that when the ordinary railroad spike is driven into the tie to hold the rail in place, the spike bends from side to side, making a reverse curve, in which shape it is held securely in place without any other fastening.



MARYLAND CAST-STEEL CROSSTIE FOR STANDARD-GAGE RAILWAY TRACK